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Bulletin No. 99. December 1907.

Agricultural Experiment Station

OF THE

Louisiana State University
and A. & M. College,

BATON ROUGE.

Japanese Persimmons

F. H. BURNETTE

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Japanese Persimmons.

F. H. Burnette.

For a number of years Japanese persimmons have been grown throughout the Southern States. For eighteen years a number of varieties have been grown at the State Experiment Station. Nearly all of the varieties grown have fruited, and although there is great confusion concerning their names, enough has been learned concerning some of the well-established varieties, to publish this brief statement of their growth and productiveness.

The Japanese persimmons were introduced into this country by the United States Department of Agriculture, largely through the efforts of Prof. H. E. Van Deman, while he was in charge of the pomological work of that department. They were grown in various sections, but it was soon found that they would not thrive well very far north of the 36th degree of latitude, hence they have been grown to some extent, more as a curiosity or novelty than as a commercial product. A zero temperature is very injurious to them—in many cases fatal.

In Louisiana they have been grown for a number of years, but not as an orchard fruit. The great abundance of the native persimmons which can be obtained so easily, and the natural taste which prevails for the native product also—have tended to prevent any widespread interest in the culture of the Japanese persimmon. In Japan, as a fruit, they have the same standing that apples possess in the Northern United States, hence are of great economic importance. They are grown in great abundance, and are put to many and varied uses. The Japanese methods of treatment to correct the astringent qualities of the unripe fruit are not fully understood in America, but investigations now in progress will determine the steps that are necessary to accomplish this object, and one of the greatest drawbacks to the growing of the fruit will thus be eliminated.

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Being so very prolific, easily grown, and having such excellent qualities for transportation, there should be nothing to hinder the extension of their culture, for the Northern markets as well as for local consumption.

It is confidently believed, that easy and successful treatment will be brought out, that will correct the astringency of the fruit before softening, and thus present a fruit that is healthy and luscious and capable of being put to a large number of uses.

CONSIDERED BOTANICALLY.

There are a large number of species in the genus to which the persimmon belongs, but only two are mentioned as of any economic importance, native to America, and two likewise native of the Orient. These are:

Diospyros Virginiana—The native wild persimmon of the Southern States.

Diospyros Texana—Wild persimmon of Texas.

Diospyros kaki—Japanese persimmon.

Diospyros Lotus—Chinese persimmon.

Everyone in Louisiana is thoroughly acquainted with the native persimmon, and as this bulletin has to deal with the foreign species, nothing especially will be said concerning the native, unless it is to mention that they are very much neglected, and unfortunately so, as there is no doubt but that they are capable of being greatly improved by selection, cultivation and crossing. A fruit that varies naturally so much in size and quality, some day will be taken more vigorously in hand and numerous valuable varieties secured and perpetuated. There are at present about twenty varieties of our native persimmons cultivated locally in various parts of the United States.

The two foreign species mentioned have been growing at the Louisiana Station for several years, the *kaki* so far being the one of value.

Specimens of *Diospyros Lotus* (?) were sent to the Station by the United States Department of Agriculture in 1897. Only one tree proved to be pistillate. These trees were grown from seeds obtained by the United States Department of Agriculture at Niu Chuang, China.

It fills the description given for *Diospyros Lotus*, differing slightly in growth, as the trees at the Station are fairly vigorous and upright growers. It is therefore mentioned here as belonging to *Diospyros Lotus.* It is said to be hardier than *kaki,* and used as a stock for it in Japan. The fruit is very small (see cut No. 1), quite black, and of no value. It has not been used as stock at the Station.

Ordinarily, the Japanese persimmon does not grow to be a large tree. Occasionally, however, a good sized tree may be seen.

Being such abundant bearers, the drain upon the tree serves to curtail the growth, and some of the varieties are little better than dwarfs. The complaints of short life of the trees, and the tendency to become dwarflike are no doubt due to over-productiveness.

The leaves of the *kaki* vary much in size and are much larger and heavier than those of our native species. The foliage is generally a dark myrtle green, and gives the tree value as an ornamental. The varieties differ as to their ability to throw off leaf diseases, some of them being very resistant. The flowers appear on the new growth and are very numerous, usually in ency, flavor and texture. Some are flat, others long, others usually they tend to bear not only to the limit of the strength of the tree, but very often overtaxing the tree.

The fruit varies in size, color, earliness of maturity, astringency, flavor and texture. Some are flat, others long, others round. Some are yellow fleshed, others orange, others tending to dark red with brown streaks. Some are edible when yet green, others are slightly astringent, others very astringent. Some ripen early in September, while others will hang on the tree almost to January. No fruit is more variable in all of these points, and up to the present there has been no classification of the fruit that is perfectly satisfactory.

METHODS OF PROPAGATION.

The universal practice in the propagation of Japanese persimmons now, is to use seedlings of our native species for stock. At first they were grown on their own roots, but the abundance of native, hardy stock was taken advantage of, and is now used. It is said that in Japan, the Chinese persimmon is often used, being hardier than the Japanese. The Japanese persimmons work readily upon our native stock, and as the latter is so abundant, hardy and rapid in growth, it leaves little to be desired as a stock.

The common method of propagation is to whip graft upon the whole root, about two inches below the surface of the ground. This is practically the only method used on a large commercial scale in persimmon nurseries. This is done very early in the season before growth starts, usually in January, sometimes later. Some growers do not wax the graft, only using common twine to tie, in order to hold the parts in close contact, and adjustment, the twine decaying by the time that a union is established. In fact, any method of underground grafting may be used with success.

The persimmons do not take very kindly to methods of budding. It is true that some propagators bud and are quite successful with them, but it requires every care and attention, with mank risks to run and dangers to overcome. Ring budding, performed late in summer—usually about August—is the method employed. It may be said also that this method in early spring has been tried by some growers. There is no doubt, however, but that root grafting is the most desirable from many standpoints, chief among them being the fact that if anything happens to the young tree through accident or otherwise, the variety is usually saved by a sprout coming from the base of the young tree above the point of union.

If anything happens to a young budded tree, the chances are that the value of the tree is lost by the losing of the bud. An accident is very apt to happen with unreliable labor or from farm animals. Seeds of the native persimmon are obtained and sown in nursery rows. The seedlings are worked generally the second year, or if large enough, one year from seed. This depends entirely upon the size of the seedling. The aim is to secure a vigorous seedling, work it, and one year from the time of root grafting, have a young tree suitable to move from the nursery row to the place of permanent growth.

CARE.

Plenty of room should always be given, usually twenty or twenty-five feet apart.

There are a few points in the care of the Japanese persimmon tree that need emphasizing. They should be set young, and great care should be exercised that the setting be given the closest attention. Being a pronounced tap-rooted plant, the necessity of great care in setting is apparent. The roots should never be allowed to become exposed to the air and sun, and in setting, the mellow moist earth should be well firmed around them. Too much emphasis cannot be placed upon the need of setting young trees, and not resetting them, unless the necessity for doing so is beyond adjusting. Occasionally inquiries come to the Station concerning the transplanting of persimmon trees after several years' growth. While this may be done, it is certainly accomplished only by the greatest risk to the tree.

Good clean culture is all that is required, the same that is given in any well-cared for fruit orchard. In our heavy lands, or on soils similar in character to the soils of the bluff lands of Louisiana, sodding over should never be allowed, if good crops are desired. Any good complete manure may be used. A good crop of cow peas turned under every two or three years will be highly beneficial. No experiments have been undertaken to find out the exact fertilizer requirements, but it is believed a well-balancd fertilizer, suitable for orchard purposes, should be the one used. The Station orchard has received no commercial fertilizers, the only treatment has been the turning under of occasional crops of cow peas, and a light coating of autumn leaves removed from the University campus. No other dressings have been used.

During the first three years the growth of the tree should be watched, in order to build a symmetrical, upright tree.

This is not easy, for some of the varieties spread too much, and the leading upright branches are often overloaded and become broken easily, or are headed back by careless removal of fruit. Ordinarily, after they begin to bear, there is little need of pruning. The tendency to overbear is so strong, that new wood is not produced in abundance, and the tree becomes dwarf-like. Systematic thinning of the fruit is necessary to control this, as it will not do to leave the thinning to natural causes, and depend upon the tree to throw off all the fruit that it can not well take care of. The weakened condition from overbearing results in a sickly tree which readily becomes an easy prey to diseases and insects, and it requires a careful observer to train his tree and thin the fruit to the proper amount.

VARIETIES.

There has always been a great deal of confusion concerning the names of the Japanese persimmons, and it may be that some of these listed in this bulletin may be known under other names. Along with the varieties first obtained at the Station, was one known as *Among*. This is not listed in the catalogues now, the *Tsuru* bearing the same description that fits the *Among* that was sent to us.

This confusion of names is not to be wondered at, however, as the Japanese names are not easy to remember, spell or pronounce, and a great deal of trouble might have been saved by giving an American name.

The following is a list of varieties that have been grown at the Station:

COSTATA. (FIG 2.)

This is a fruit of medium size, slightly pointed, diameter varying from two to three inches, color of skin a light orange yellow, flesh also of light color. It is seedless (Fig. 3), strongly astringent until fully ripened, and keeps late. The tree is a good grower, prolific bearer, and makes a fine appearance in full fruit. Season, October 10th-November 10th .

HACHIYA.

This variety is very large and when in full fruit makes a striking appearance. Fruit is a reddish yellow, fine specimens measuring four inches in diameter and oblong; flesh, deep yellow, with occasional seeds. Also astringent until it softens. Season, September 20th-November 20th.

HYAKUME. (FIG 4.)

The *Hyakume* is also one of the largest of the Japanese persimmons. The tree is very prolific and shapely. Fruit approximately three inches in diameter and somewhat conical. Color of skin, light reddish yellow; flesh quite dark (Fig. 3) and seed-

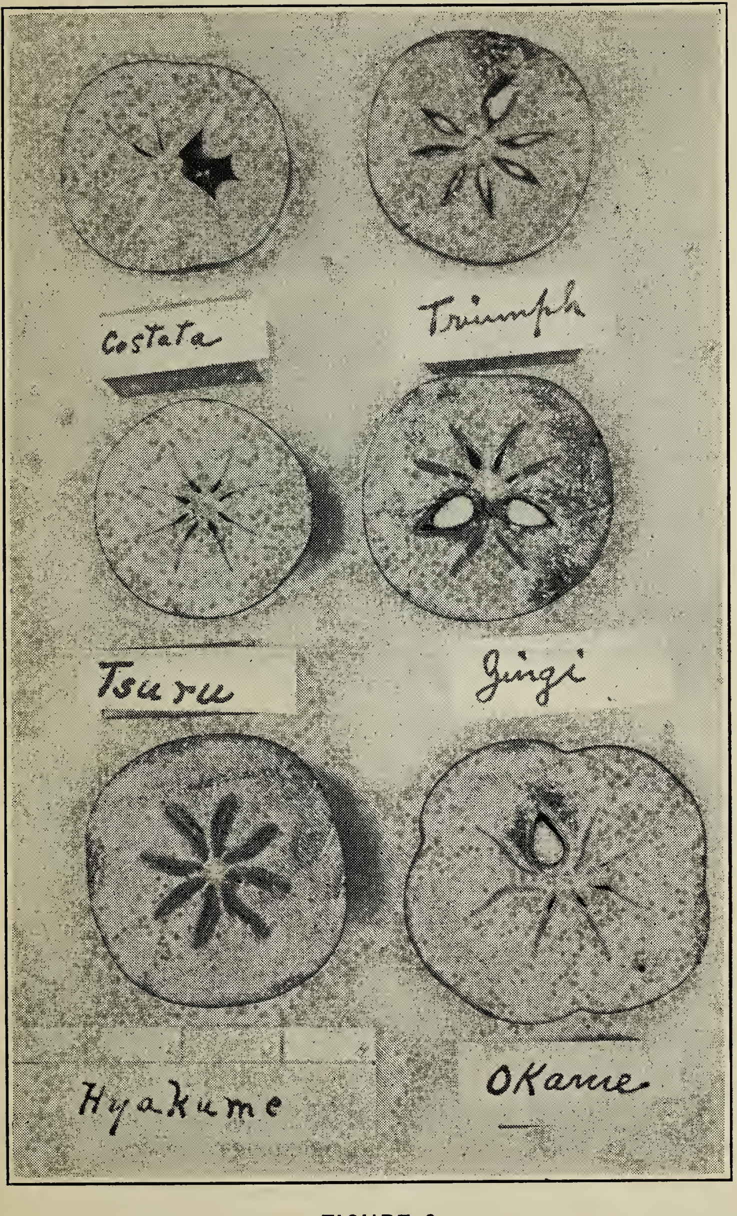
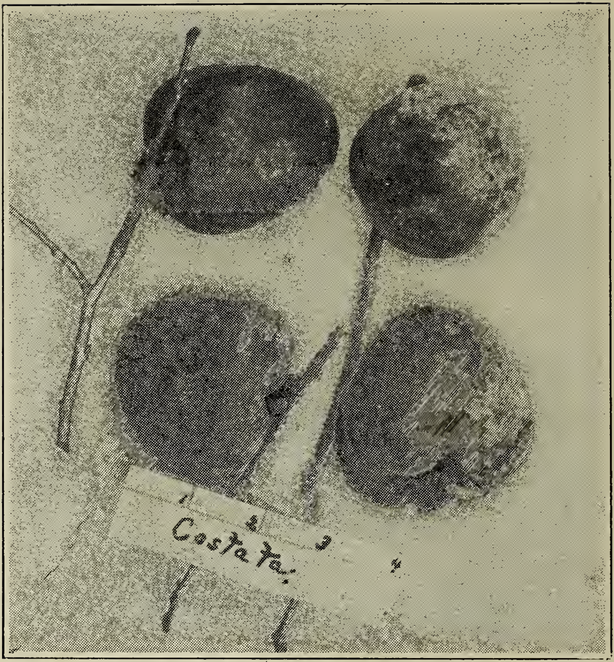


FIGURE 3.



COSTATA. (FIG. 2.)

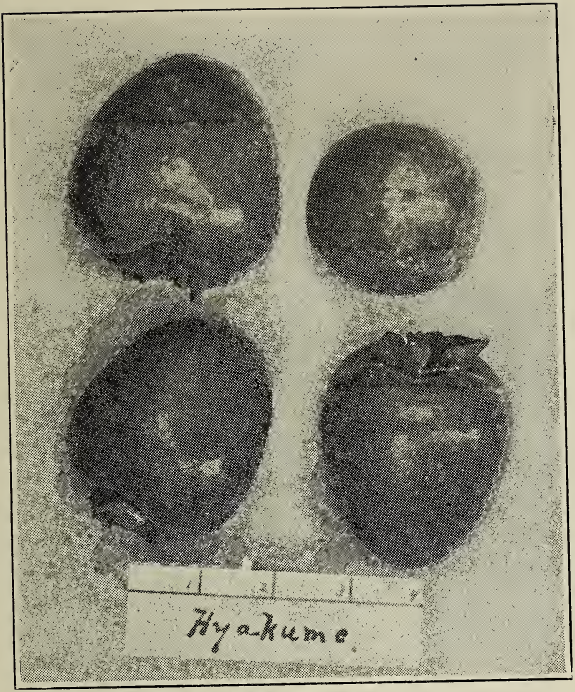
less. It loses its astringency early and has a good flavor. Some specimens may be pealed and eaten before softening. Season, October 15th-November 15th. A very desirable variety.

MYOTAN. (FIG. 5.)

This variety is not a strong grower, but is usually quite prolific. Fruit is nearly round and runs about two inches in diameter. Color is dark reddish yellow, and flesh is dark red with brown streaks, has numerous seeds, and is edible when hard. Has no astringency noticeable. May be pealed and eaten the same as an apple and has a pleasant flavor. Season, September 1st-October 15th.

NERO ZAMI.

This variety was one of the first planted in the grounds and



HYAKUME. (FIG. 4.)

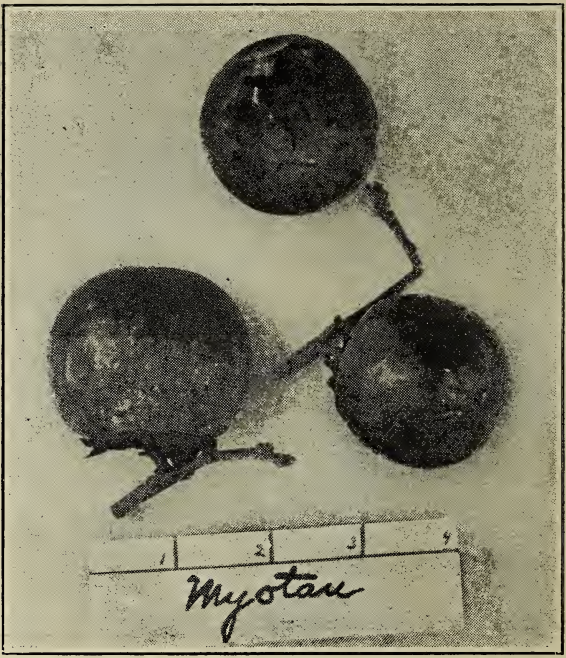
proved to be a weak grower. Fruit is small, nearly round, dark red in color, dark flesh and many seeds. It resembles the *Myotan* in size and appearance. Not prolific and not desirable. Season September 20th-October 20th.

OKAME. (FIG 6.)

This is a large tomato-shaped persimmon, usually three to three and one-quarter inches in diameter, flat and with quarters well marked. Tree a vigorous grower and very prolific. Color of fruit is a dark orange red, and flesh is deep yellow, with only now and then a seed (Fig. 3). Astringent until ripe. Season, September 20th to November 1st.

TABER, NO. 23.

This is a seedling grown and sent out by G. L. Taber, Glen



MYOTAN. (FIG. 5.)

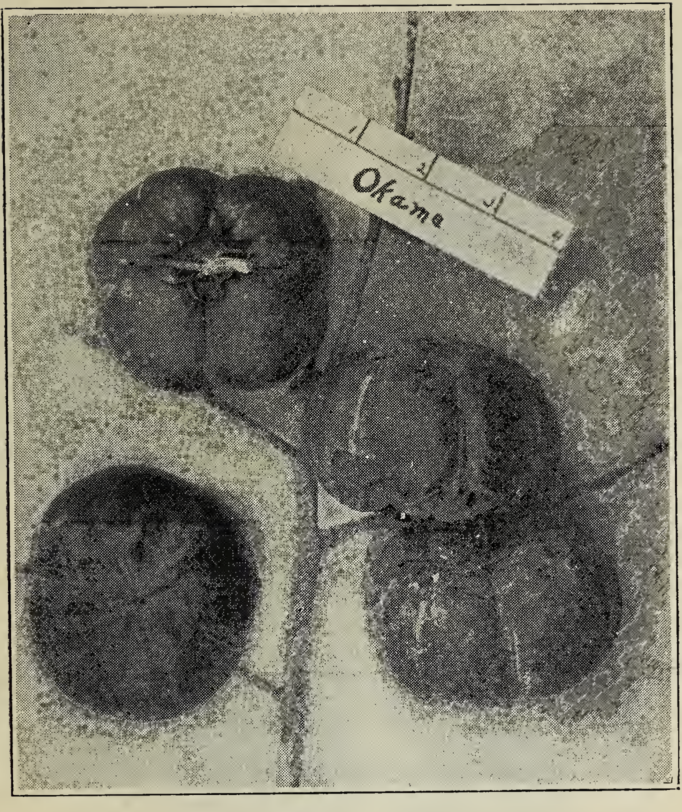
St. Mary, Florida. Color, dark red; flesh, dark, full of seeds and prolific. Not astringent. Season, September 15th to October 15th.

TABER. No. 129.

This is another seedling grown by G. L. Taber of Glen St. Mary, Florida. It is round and runs from two to three inches in diameter. It is dark in color, and the flesh is also dark and is edible when hard and immature. Season, September 15th to November 1st.

TANE NASHI. (FIG. 7.)

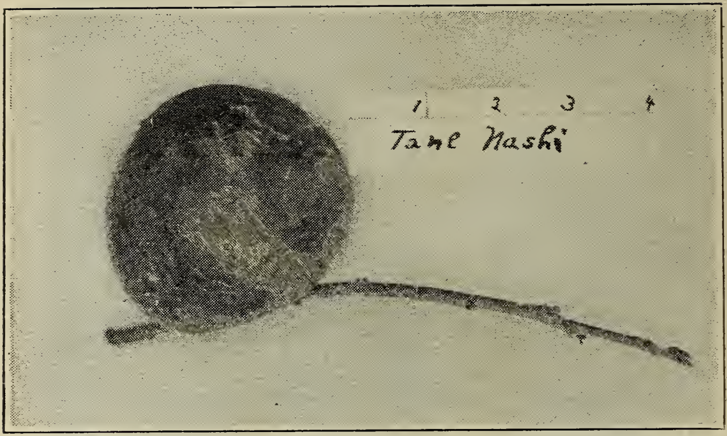
This is one of the large persimmons, nearly round, with a very small pointed tip, and about three and one-half inches in diameter. Color is a yellow red, bright and attractive; flesh also light in color, and seedless.



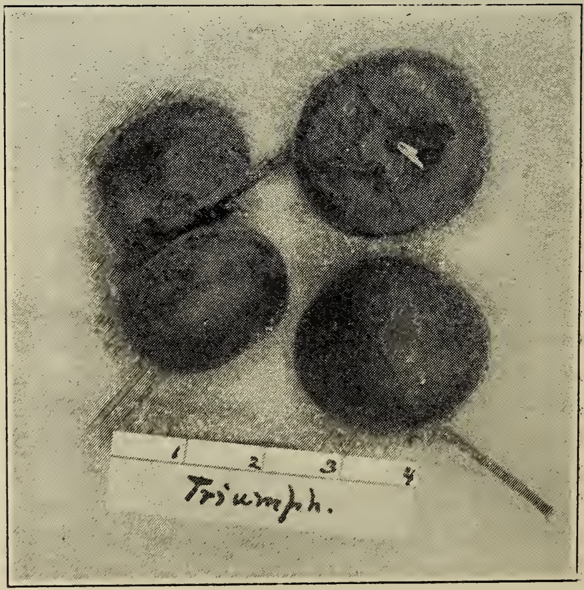
OKAME. (FIG. 6.)

TRIUMPH. (FIG. 8.)

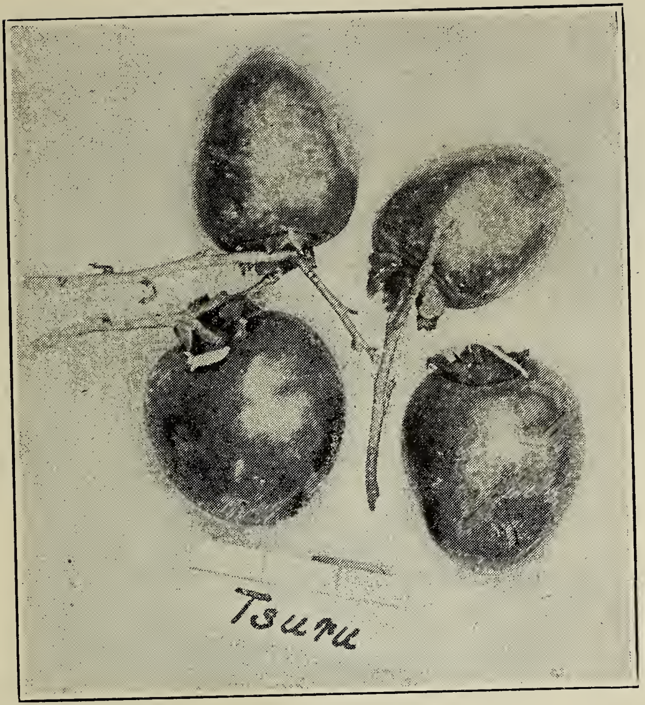
This variety came to the Station under the name of a seedling of the honey persimmon, and was identified as the Triumph by Prof. H. Harold Hume of Glen St. Mary, Florida. It is one of the most vigorous and healthy trees among the Japanese varieties, is upright in growth and has beautiful large myrtle green leaves, free from disease. The fruit is rather small and flat, about two and one-half inches in diameter and of a beautiful bright yellow red color. Flesh is yellow and has seeds. (Fig. 3.) Slightly astringent until softening. The most delicious of the Japanese varieties. Season, September 20th to November 20th.



TANE NASHI. (FIG. 7.



TRIUMPH. (FIG. 8.)



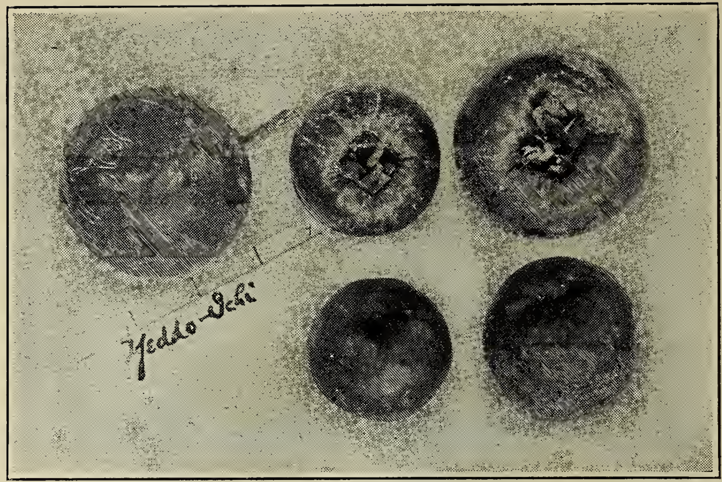
TSURU. (FIG. 9)

TSURU. (FIG. 9.)

While there may be some doubt that the figure shown under this name is the true *Tsuru,* but is believed that it is. It came to the Station as *Among,* but answers to the description given in the catalogues as *Tsuru.* It is long fruited, fully an inch longer than its diameter, which is about two and one-half inches. In color it is yellow red, and its flesh is on the same order. Most of the specimens are seedless. Very prolific. Season, October 1st to November 1st. (Fig. 3.)

YEDDO-ICHI. (FIG. 10.)

At the Station, this variety is medium in size and nearly round. It runs about two and one-half inches in diameter Color of skin dark, and flesh dark and brownish, and contains seeds. It is edible when hard, and has a very pleasant flavor.



YEDDO-ICHI. (FIG. 10.)

The tree is a good grower and is very prolific.

ZINGI. (FIG. 11.)

This is a very heavy bearing vigorous tree, and the fruit is nearly round, running about two and one-half inches in diameter. Color, medium red, and flesh darker with seeds. (Fig. 3.) Like the *Myotan,* it is edible when hard. Season, September 1st to October 1st.

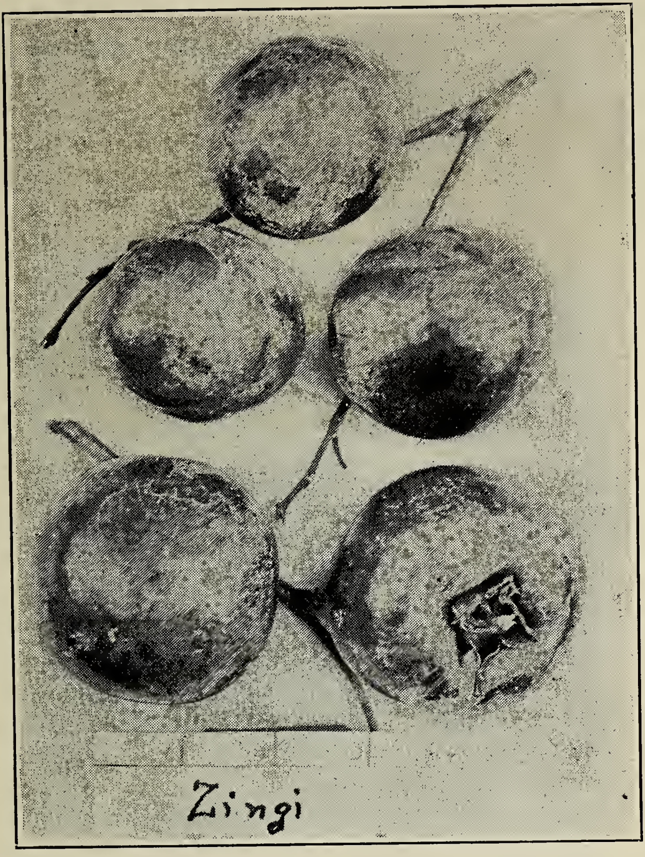
KORA KAMI.

The variety at the station under this name resembles the *Zingi* in many particulars, and possibly may be the same. The tree is not as vigorous or prolific as the *Zingi.* It was a weak grower and died after bearing three years.

SEEDLING. (FIG. 12.)

This variety was sent to us as a seedling. It is a very vigorous grower, with fruit nearly round, running from two and one-half to three inches in diameter, bright in color and flesh light, seedy and astringent. Season, September 10th to October 20th. Very prolific.

The persimmons shown in Figure 13 are various types of



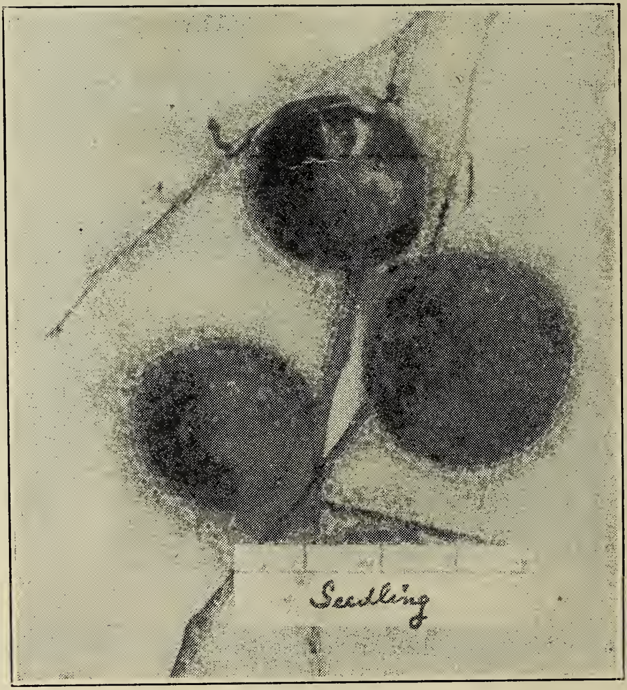
ZINGI. (FIG. 11.)

native persimmons, and are presented only to form a comparison of the native and foreign varieties.

In Figure 1 are shown specimens of *Diospyros Lotus,* the Chinese persimmon and the Honey, a variety of our American species.

THE FRUIT AND ITS TREATMENT.

As some of the varieties are edible before becoming soft, that is, they are not astringent, it follows that in the event of a Northern market, these varieties would be the most desirable to grow. To one not acquainted with persimmons, a single effort to eat an unripe specimen would be sufficient to prevent any expansion of the market. It has been found that in Japan the astringent varieties are subjected to a method of treatment, by which the hard unripened fruit is confined in sealed recepticles for certain periods of time, after which upon removal, it is found that their astringency has disappeared. It has been found, too, that subjecting the astringent fruit to the fumes of certain chemicals will accomplish the same purpose, and while very small experiments were carried out at the Station this season, sufficient information was not obtained to warrant a statement at this time. It is sufficient to say that the treatment of the astringent fruit in order to correct the astringency is a problem that will be successfully solved in the very near future, thus removing the greatest hindrance to the growing of



SEEDLING. (FIG. 12.)

Japanese persimmons, and the further expansion of an excellent market for them.

As a fruit they are rich in sugar, the different chemical analyses showing an average of about 16 per cent for the cultivated varieties. While this is slightly less than the percentage of sugar in our native varieties, it is much greater than the amount found in apples, which average less than 8 per cent. An alcoholic beverage is made from them in Japan.

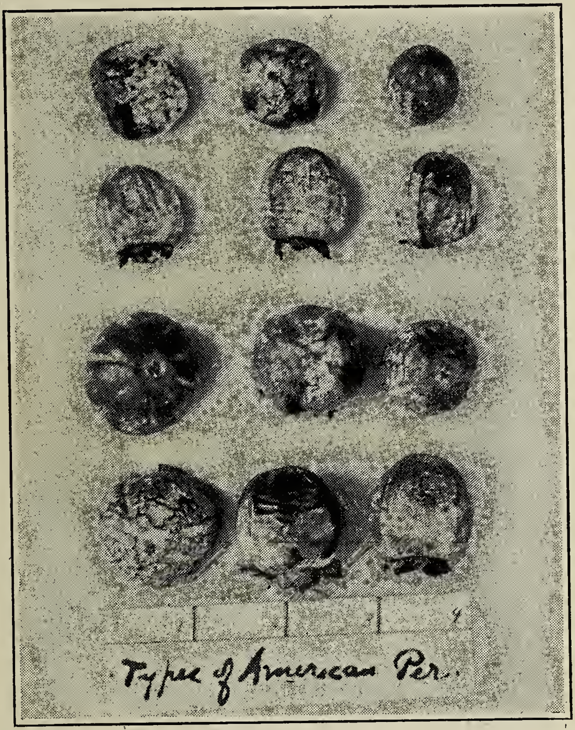


FIGURE 13.

They ripen before frost in Louisiana—in fact, a frost is not necessary for their maturity, contrary to the prevailing belief.

ENEMIES AND DISEASES.

There are comparatively few enemies and diseases of a very serious nature, that attack the Japanese persimmons. There are several leaf diseases, which nearly defoliate the trees very late in the season. As this occurs really about the time the leaves begin to fall, little damage is done. Some varieties are much more resistant to fungous diseases than others. The seasons also vary, and some years the diseased leaves are hardly noticeable. In the event of serious trouble from leaf-destroying diseases, there is always a remedy at hand in the Bordeaux Mixture, which is universally used for the purpose of preventing or checking them.

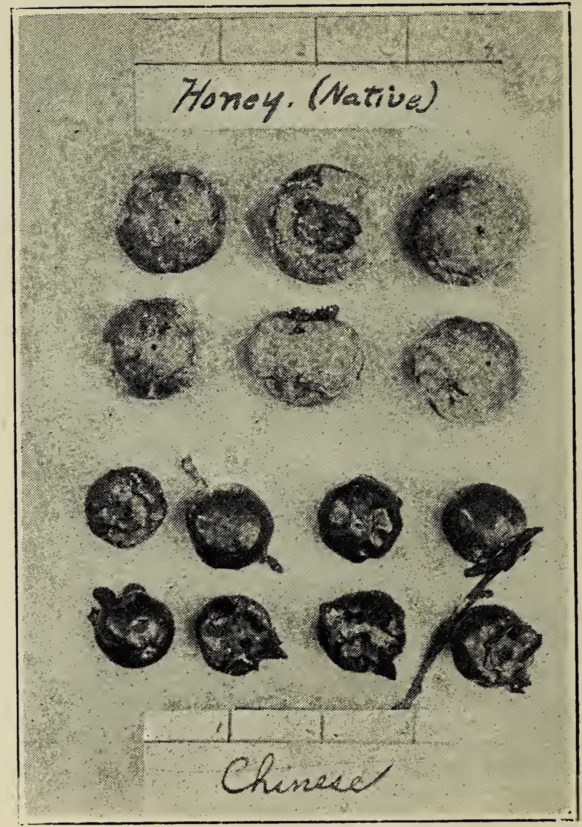


FIGURE 1.

Among the insect pests, the Twig Girdler (*Oncideres cingulatus*) is the one most frequently heard from. The female beetle, which is about one-half an inch long, and of a dark gray-brown color, deposits her eggs near the end of the young twigs, and girdles the twig below them.

In due time the twig dies, breaks off and the young hatch and come out. A few complaints have been made concerning the girdler. The remedy is to gather the twigs and burn them, not a very difficult task to do, and if the fallen leaves and broken twigs be raked and burned from each tree, not only will the Twig Girdler be under control, but the leaf diseases also will be held in check.

By far the most serious pest at the Station has been the mocking bird. At the time the Japanese persimmons are beginning to mature, there is a scarcity of food for them and they injure a great many.

Some years this becomes a serious question. To cover the trees with gauze is out of the question. No one would think of shooting the mocking bird as a pest, outside of the fact that it has legal protection. The remedy will come with the future treatment of the persimmon for market. Gathered while still hard, treated for astringency and put on the market while still solid but edible, the fruit will be cared for and put before the consumer before the mocking birds make any serious attacks upon them. While there are other birds which are troublesome, the one mentioned is the chief offender.

MARKET.

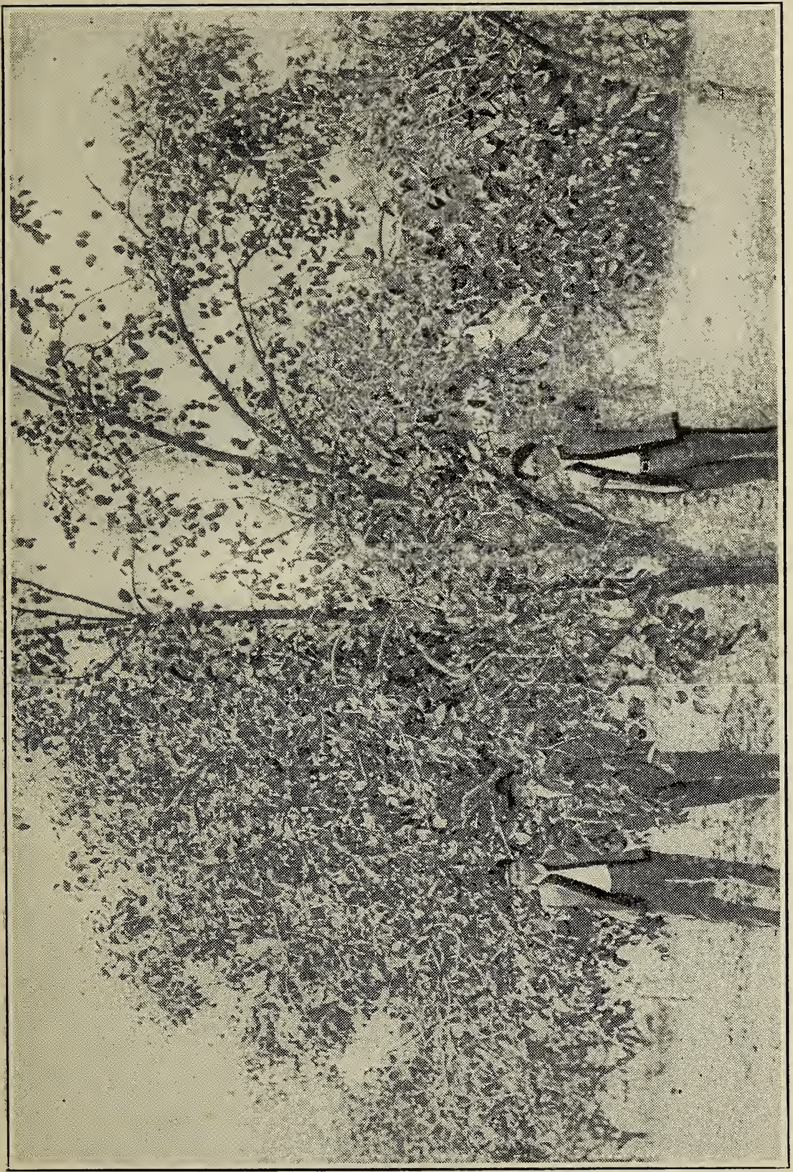
The Northern people love tropical and semi-tropical fruits. Our own people love a variety of fruits. The first Japanese persimmons put upon the markets in the South and the North were received with caution, yet when well ripened, were easily disposed of. The present sources of supply of these fruits are California, Florida and Louisiana, with California leading. While in our Southern markets they are found in bulk, the Californians pack and ship in neat crates. The California crate is similar to an egg crate, with capacity for 50, 36 or 32, according to the size of the fruit. The fruit is unwrapped and through the slats of the crates it makes a very good appearance, and the prospective buyer can readily see the size, color and quality without breaking the package. These crates of persimmons sold in the Chicago market during November, 1907, for $1.10 to $1.30 per crate. This means a very good profit to the grower, and there is no reason to believe but that good Japanese persimmons, packed nicely, will continue to find a good market for some time to come. In bulk they bring about $1.00 to $2.00 per bushel, and by the dozen 30 to 80 cents.

USES.

While we are not fully acquainted with all the uses to which Japanese persimmons are put in their native country, it is quite probable that their use is as varied as is the case with apples in the Northern States. Its general use at the present time, however, is as a fresh fruit. When fully ripe, it may readily be eaten out of hand, but as some varieties are quite soft, the use of a spoon will facilitate matters greatly. Some prefer them served with cream. The non-astringent varieties may be pealed and eaten as a desert fruit, or sliced and served as a salad. Their characteristic flavor, varying in the different varieties, is found to be delicious by a great majority of people. Methods of preserving or evaporation have not been ascertained, but the latter is a common practice in Japan.

CONCLUSIONS.

1. Japanese persimmons may be grown with the greatest success in all sections of Louisiana.
2. They are easily grown, easily marketed and stand transportation well.
3. A ready market awaits them.
4. They are delicious as a salad or desert fruit.
5. A number of the varieties are not astringent, therefore may be eaten while still hard.
6. Astringent varieties will soon be treated so as to correct this undesirable quality.
7. They have comparatively few diseases and enemies.
8. They are valuable as an ornamental tree in the home yard.



JAPANESE PERSIMMON TREE IN FRUIT.

Bulletin No. 100 January, 1908.

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The Root Disease of Sugar Cane

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Root Disease of Sugar Cane in Louisiana

HISTORICAL.

The root disease of sugar cane was first described from Java in 1895 by Dr. J. H. Wakker, who gave it the name ''Dongellanziekten,'' the disease of the underground part of the cane stalk. He observed the disease on the sprouting cuttings of the ''nurseries'' and the older canes of the fields; and he found the causative organism to be a fungus which he described and proposed as a new species, *Marasmius sacchari.* This fungus, primarily a saprophyte, has acquired the habits of a wound parasite, and finds in connection with cane cuttings and cane plants conditions most favorable for its full development and fruiting.

At about the same time studies upon a similar disease were begun in the British West Indies, and were carried on for a number of years by several investigators. An extensive account of the disease, however, was not published until 1903, when Mr. A. Howard gave the results of his studies in Barbadoes. He attributes the disease to Wakker's species of *Marasmius*, and adds materially to the knowledge of the conditions favoring the attacks of the fungus upon the cane plant. Further observations made by Mr. F. A. Stockdale lead to the opinion that probably more than one species of *Marasmius* attack sugar cane in the West Indies.

In 1905 Mr. L. Lewton-Brain published a preliminary account of the disease in the Hawaiian Islands, and in 1906 there followed a very complete account by Dr. N. A. Cobb. According to these writers a certain amount of the root disease occurring in the Hawaiian Islands is caused by a species of *Marasmius* which differs in minor characters from Wakker's species, and is accordingly proposed as a new variety, *Marasmius sacchari* variety *hawaiiensis.* Dr. Cobb also attributes a considerable amount of the root disease in the Hawaiian Islands to a fungus of a very different type, *Ithyphallus coralloides,* a member of the so-called stink-horn group of fungi. He expresses the belief that further study will show that still other fungi, having the same general mode of living, play a part in causing root disease.

APPEARANCES INDICATIVE OF ROOT DISEASE.

Affected stools show very constantly and markedly root systems that are deficient in their development, and that show a considerable percentage of dead roots. Such stools have a weak hold on the ground and may be pulled up with comparative ease; they are also the ones most generally prostrated by storms. The canes of these stools are reduced appreciably in size and weight. The leaf system is reduced; and when the supply of available moisture in the soil falls below normal, symptoms of water starvation are apparent, while other stools maintain a normal appearance. When the drouth conditions become more severe, a large percentage of affected stools die. These effects are caused by the deficiency in root system. They are more pronounced in stubble than in plant cane, for reasons that will be indicated later. The lower leaf sheaths (shuck) of affected canes do not fall away, leaving the older part of the canes clean, as is normally the case, but they adhere closely for some distance, as much as eighteen inches, from the surface of the ground, and can be removed only with difficulty. (Fig. 1.) They are seen to be cemented together by the whitish mycelium of a fungus which has a characteristic moldy odor. Under favorable conditions, which seem to occur with comparative infrequency, the toadstool fructifications of the fungus are to be found in connection with the mycelium.

This fungus which cements the leaves is the organism that causes the destruction of the cane roots, from which result the acute symptoms of disease and the ultimate reduction in the yield. The fungus is primarily a soil-inhabiting organism, and its appearance above ground on the somewhat moist and nutritious leaf sheaths where conditions are favorable for its growth, is rather incidental. The fungus may infest a stool of cane, especially in the plant crop, and cement the sheaths in the characteristic way, and yet not affect the roots or injure the stool appreciably in any way. Such a stool can not strictly be regarded as diseased; and yet with the fungus present it is probable that sooner or later the living tissues will be permeated, and typical root disease induced. On the other hand, even in stools that suffer most from root disease, it is usual to find a certain percentage of the individual canes without indications of the fungus above ground. But with all of this, the matting of the leaf sheaths is a most useful indication of the actual or potential presence of root disease. This matting is not very conspicuous until about the time the cane "begins to joint," about August.

THE CAUSE OF ROOT DISEASE.

It has already been indicated that in other countries several distinct fungi have been found to play a causative role in inducing root disease; and we are led to regard the root disease of sugar cane as one presenting a definite group of symptoms which result from the destruction of the cane roots by the attacks of some one of several fungi which differ much in their taxonomic relations, but have the same general life habits. These fungi are not aggressive parasites; for the most part they flourish on non-living parts of the cane, and only under special conditions and in particular situations can they directly attack living tissues.

In Louisiana, a species of fungus which is regarded as being in all probability *Marasmius plicatus,* Wakker, is found constantly associated with growing cane or with decaying cane parts. The canes on which it occurs show generally, though not invariably, a dwarfed growth, a reduced root system, and, during a period of drouth, are the ones to succumb most readily; canes without the fungus have nowhere been observed to show generally these symptoms. Mycelium of the fungus has been observed in living and dead roots. Repeated inoculations with pure cultures have produced in living young cane plants the characteristic symptoms of root disease. The fungus has been recovered in pure culture from such artificially infected plants.

These facts lead to the conclusion that the species of *Marasmius* found generally on sugar cane in Louisiana, which is regarded as *Marasmius plicatus,* Wakker, must be added to the list of fungi that have the ability to induce the so-called root disease of sugar cane.

Specimens of Louisiana cane showing the characteristic mycelial growth, but not the fructifications, have been submitted to the proper authorities at the experiment stations in Java, Hawaii and Barbadoes. In all cases the reports have been that in so far as could be judged from the material, the appearances were those of root disease.

With regard to two species of fungi belonging to the stink-horn group, and found in some numbers in the cane fields of the State, definite statements cannot be made at present.

THE FUNGUS.

Marasmius plicatus belongs to the toadstool or mushroom group of fungi. In common with other members of the group, the organism has a vegetative part known as the mycelium, made up of minute branching white threads which ramify through the nutrient substratum. It is this mycelium that is found infesting the dead roots and the matted leaf sheaths of the cane plant. When conditions of moisture and food supply are favorable there develop in connection with the mycelium the fructifications of the fungus. They appear at first as small, ball-like masses of mycelium; these increase in size, and gradually become differentiated into the component parts of the fully developed fruit body. These fructifications are seldom observed since they are formed with comparative rarity, and since they remain fresh for a very short time.

The fruit body (Figs. 2 and 3) has the characteristic toadstool form, with an upper expanded portion, the cap or pileus, and a supporting stalk, the stipe. The pileus is dirty white, becoming somewhat darker with age; it is usually about three-fourths of an inch in diameter, but may attain a size of an inch and one-fourth. When young it is convex, and at maturity is almost flat or perhaps slightly concave. Its surface is smooth. On the under side are the radiating gills which have an even, thin edge, and a straight, radial direction. The long gills extend from the margin to the stem, and are attached to the stalk itself rather than to a prominent ring about the stalk. Other shorter gills extend from the margin just far enough to fill in the angles between the longer gills. The stipe is about equal in length to the diameter of the cap, or in some cases, somewhat less. It usually arises from the side of the leaf sheath, and is somewhat curved so as to bring the cap into a horizontal position. It is normally attached to the cap at its central point, but at times this attachment is somewhat eccentric. The stipe is smooth externally, except at the base, which is downy and also enlarged. The whole fruit cap persists for about a day, and then gradually dries, losing its form, but not undergoing immediate disintegration. When moistened it regains something of its original form. The gills produce upon their surface the spores of the fungus (Fig. 7), which are minute oval bodies of microscopic size. They show a pure white color in mass. Their function is to reproduce the fungus plant. This they do, under suitable conditions, by sending out a small thread which may by its continued growth develop into the mycelium of a new generation of fungus.

This fungus grows saprophytically upon decaying vegetable matter, seemingly showing a rather strict selective preference for parts of cane plants. In the laboratory it grows well upon a wide range of nutrient media. In addition to this saprophytic mode of living the fungus has the ability to attack living tissues, probably only when their vigor is impaired, and thus to adopt the mode of life of a parasite. It is in this role that the fungus becomes of economic importance in causing damage to cane plants.

MODES OF DISTRIBUTION.

The spores of fungi are the parts specially formed and adapted for the reproduction and dissemination of the parent organism. Spores are produced in very large numbers on the under side of the fruit caps of *Marasmius plicatus,* and they germinate with comparatively little difficulty. But the fruit caps are produced only under exceptionally favorable conditions, and there is no evidence of any increase of the fungus following the production of the spores in a given locality. In the mushroom group as a whole reproduction by spores seems to be of relatively little importance. On the whole, it seems probable that spores have a comparatively unimportant part to play in the propagation of the sugar cane *Marasmius.*

To a much greater extent than among higher plants, detached portions of the vegetative part of fungi can reproduce the plant. Bits of the mycelium of the root fungus of sugar cane grow and spread rapidly under favorable conditions. A small amount on the butt of a planted stalk may be the means of infecting one or more stools of the plant cane to which it gives rise. It is thus by the planting of infected stalks that the root fungus is most efficiently spread from field to field, and continued from year to year.

During the season of 1907 three field tests on two plantations in West Baton Rouge Parish were made to determine what part the planting of affected canes play in the continuance and spread of the fungus. The results were as follows:

Experiment	Rows	Seed Cane	Percentage Affected Stools	Percentage Affected Stalks
A	1	Affected whole stalks	73	30
A	2	Sound whole stalks	23	17
B	1-3	Affected whole stalks	85	63
B	4-6	Sound whole stalks	63	35
C	1-4	Affected whole stalks	89	61
C	5	Affected lower halves	100	91
C	6-10	Sound whole stalks	1.7	0.7

It is noticeable that the amount of fungus was constantly greater when affected stalks were used for planting, and was greatest for the row planted with the lower halves only, that is, with the part having the fungus most abundant. At the outset nothing was known regarding the amount of the fungus that might be present in the soil. In experiments A and B it was later very evident from the showing of the control rows and of the fields in question generally, that the soil was everywhere thoroughly infested with the fungus. This accounts for the rather high percentages for the rows planted with sound cane in these two tests. In experiment C there was very little evidence of the presence of the root fungus in any part of the field, and the control rows remained almost free from it. The cane used for the general planting in all three fields was from the plant crop and showed an unusually small percentage of stalks with adhering shuck.

A third means of distribution is by the persistence of the mycelium of the fungus in the decaying roots and other cane trash of the fields. A certain amount of such infected material must of necessity remain over from one season to the next and can become the source of infection for the new crop of cane. The root fungus similarly protected can withstand lower winter temperatures than can the cane. Young cultures were killed by an exposure of six hours to temperature ranging from 3 degrees to 14 degrees Fahrenheit, but survived an exposure of 45 minutes to the same range. Exposure to 32 degrees for six hours was not fatal. Growth took place slowly during a prolonged exposure to 50 degrees Fahrenheit, and most rapidly at about 85 degrees Fahrenheit. Young cultures survived exposure of 45 minutes to 122 degrees Fahrenheit, but were killed by exposure to the same temperature for one and one-quarter hours.

Further data are necessary before statements can be made regarding the period of persistence of the fungus in the soil when not planted in cane.

OCCURRENCE IN LOUISIANA.

The root disease of sugar cane has existed for a long time in Louisiana and is now distributed rather evenly through all the cane-growing districts of the State. Fructifications which have rendered the identity certain, have been collected from six parishes, and canes with matted leaf sheaths of characteristic appearance have been seen from as many more parishes. The percentage of infestation varies much with local conditions, there being often more noticeable differences in this regard between different parts of the same plantation than between the plantations themselves. It is a usual thing to find the purple plant cane affected to the extent of 5 to 8 per cent of the stalks, and purple first-year stubble 12 to 18 per cent. In the case of D 74, 1 to 3 per cent and 4 to 8 per cent are usual figures for the corresponding crops. Some of the worst fields seen have been in purple cane, and have had 90 or 95 per cent of the stalks infected.

These figures are not to be taken as representing in any way the loss due to the root disease. Affected canes, although usually small and light, are by no means a total loss. And the figures do not take into account the gaps in stands and the reduction in number of canes per stool, that make up the large loss from root disease.

It has been very generally observed that D 74 shows a less degree of infestation than purple. The following figures, which are based on counts from comparable plantings, give indication that the seedling canes D 74 and D 95 are less infected than the two most common home varieties when grown under the same conditions:

FIRST YEAR STUBBLE.

	Fall Plant.	*Spring Plant.*
Striped	34.3%	30.6%
Purple	26.6%	22.9%
D 95	22.2%	16.7%
D 74	14.4%	15.0%

Each percentage represents the average condition of nine rows. The cane used for spring planting was windrowed from the lot from which that used for fall planting was taken.

From another planting during a different season the following figures have been deduced:

SECOND YEAR STUBBLE.

	Fall Plant.
Striped	27.9%
Purple	20.2%
D 95	15.3%
D 74	12.5%

Whether this difference is due to a greater natural resistance in the new canes, such has been reported for the Yellow Caledonia variety in the Hawaiian Islands, or whether it is merely the result of the newness of the varieties, which, on account of great care in the handling of them, have been up to this time less exposed to infection by the root fungus, are questions that can be definitely answered only after further investigation. Nothing is known regarding the relative amounts of infestation of the seed cane used in the above-mentioned plantings.

MODE OF ATTACK.

The two ways in which the root disease fungus works injury to the sugar cane are by destroying the roots, and by smothering the germinating buds. In each case the effect may be produced in an indirect and mechanical way, or more directly by the parasitic attacks of the fungus.

When a number of leaf sheaths are firmly cemented about a portion of the stalk, there is a very serious obstruction to the proper growth of eyes and roots from the nodes involved. It is frequently the case that before such canes are cut, roots are protruded in large numbers from the enveloped nodes above ground; these grow to the length of a fraction of an inch and die, their tips becoming black and shrunken, and their tissues dry and spongy. A microscopic examination shows generally the mycelium of the root fungus within their tissues (Fig. 6). When cuttings from such badly enveloped canes are subjected to conditions suitable for the development of roots and shoots, it is found that in number and vigor of both, such cuttings fall far below sound cuttings, and appreciably below cuttings of the same lot from which the adhering shuck had been removed before planting.

The fungus has the power to attack roots at any period of their growth. When it is brought in contact with a root either naturally or artificially, there can be seen at the first a reddening of the surface of the root at the place of contact; this is followed by a brown discoloration of the area, and later by slow disintegration. A microscopical examination in the early stages shows an abnormal condition of the cells of the affected area, but does not show any penetration of the fungus even into the outermost cells. A little later the fungus is found to have invaded these cells, and by degrees it extends to remoter portions of the root, its advance being always preceded by the death of the cells just ahead. This killing of the cells is in all probability brought about through the agency of substances excreted by the fungus.

The parasitism manifested in these attacks is of a low and weak sort. Unlike more accomplished parasites, which can penetrate and draw sustenance from the living tissues of the host without destroying them, the root fungus of sugar cane must kill the tissues before it can invade or feed upon them. In living upon such tissues only after they are dead, it shows nothing more than a saprophytic mode of living; but the ability which it has to kill lifts it a little above the rank of saprophyte and entitles it to be regarded as a weak parasite.

The abundant presence of the fungus in the adhering leaf sheaths of affected cuttings places it in a situation most convenient for attacking the roots as they are put forth. The growth upward of the fungus on the outer and lower leaf parts of the developing shoot gives it a similar situation with respect to the roots subsequently developed from the underground nodes of the daughter plant. Its persistence on such underground parts of the plant cane keeps it in a position to attack most readily and at an early stage the growing parts of the stubble crop.

CONDITIONS FAVORING ATTACK.

There is a constant struggle for supremacy between a parasite and its host. Those host plants that possess greatest powers of resistance are affected slightly or not at all; less resistant plants succumb readily. In the case under consideration, the balance seems very even between the root fungus and the cane plant. When all conditions are conducive to vigorous, thrifty growth of the cane, the fungus, though present about the stool, has little or no effect upon it. Anything that disturbs such an optimum condition of the cane and weakens it, may be the occasion of more successful attacks by the fungus and greater consequent destructiveness. Cane requires careful cultivation for its best development; the root fungus is a wild plant, a low organism having the ability to withstand and to thrive under a far wider range of conditions than its host. In this way the fungus enjoys an initial natural advantage in the struggle.

Some of the more important conditions that tend to lessen the vigor of the cane and its powers of resistance, and so to increase the chances for the fungus to work injury, are these:

1. *Slowness of germination and early growth.* It is a matter of common observation that fall plant cane and more especially stubble cane have a larger percentage of infection than spring plant cane. This condition probably arises from a long continuance under ground of the fall planted cane and the stubble stocks before active growth begins, during much of which time the root fungus grows, becoming so well established upon the cane parts as to readily infect the young plants; and infection is further favored by the slow and intermittent character of the growth at first from these parts. It is further

likely that the canes from a stubble crop so generally used for fall planting, have a higher initial infection than the seed cane used in spring planting; this would account for a certain difference in the degree of infestation of the resulting crops.

2. *Improper cultural procedures.* It goes without saying that cane is below its best when proper care has not been taken in the preparation of the soil for planting, and in all subsequent operations until the crop is laid by. The point to be emphasized in the present connection is that the unhealthy, weakened condition of the cane that is the direct result of poor cultivation, is itself a predisposing factor for the destructive attacks of the root fungus. Especially serious are these when cane in its earlier and more susceptible stages of growth has its powers of resistance weakened by improper or inadequate cultivation.

3. *Unsuitable soil.* The root fungus through its ability to subsist upon decaying plant parts, may be found rather abundantly in soil too thin for the proper growing of cane. The under developed and struggling cane plants in such unfavorable situations may fall an easy prey to the root fungus.

4. *Bad drainage.* It is commonly the case that heavy, poorly drained soils show very large proportions of the canes infested with the root fungus. The wetness of such lands makes them especially suitable for the growth of the fungus; and the lack of proper drainage prevents the best development of the cane, with a resulting increase in infection.

5. *Unfavorable seasonal conditions.* Drouth conditions are those under which the worst effects of the root disease are brought about. These effects are not due to any spread of infection to new stools, but to the rapid and pronounced deterioration of stools already infected, the stubble crops being affected far more extensively than the plant crop. The stunting and dying of the stools in such periods of drouth follow directly from the insufficiency of their root systems; and it has been pointed out that the root disease fungus, by attacks upon the young roots, may and does seriously reduce the root systems of the affected stools. In a favorable season those stools, with a slight reduction in root system, show little or no falling off, and even those with a considerable reduction survive, with a loss, however,

in number and size of canes. But when conditions are such as to render it difficult or impossible for stools with full root systems to secure the proper amount of water and food materials, those stools at all lacking in roots suffer appreciably; and those greatly lacking in this regard die.

6. *The stubble crop.* The root disease seldom causes great loss in any but the stubble crops. Some of the causes of this have been indicated. On the one hand, the root fungus has had a chance during the interval between the taking off of the plant crop and the sprouting of the stubble canes, to become thoroughly established in the trash and decaying parts about the stumps. On the other hand, the roots and shoots begin their growth under very disadvantageous conditions which result in large measure from the impossibility of thoroughly working the soil immediately around the stumps.

In addition to causing the death of stubble cane during its period of growth and the general stunting of affected stools that survive, the root fungus probably plays an important part in killing entirely during the winter months some of the stools so as to leave noticeable gaps from the very first in stubble crops when the plant crops had a perfect stand. It is believed that this effect is brought about by the complete killing and smothering of roots and eyes, rather than by disintegration of the nodes themselves through the direct agency of the root disease fungus.

PREVENTIVE MEASURES.

Procedures for the control of the root disease are at once suggested by an understanding of the modes of invasion and dissemination of the fungus, that is, its causative agent. Briefly summarized, such procedures must follow the lines of proper cultivation and the use of sound seed cane. Preventive measures must be relied upon, not remedial ones.

1. *Careful cultivation.* It is necessary but to mention in this connection proper tillage, active and thorough cultivation, especially of the stubble crops, good drainage, and rotation of crops. When it is a matter of combatting root disease, all possible care must be taken that the environmental conditions of the cane plant are such that it may maintain a healthy and vigorous condition especially during the critical period of early

growth. Effective resistance at this time goes far toward securing freedom from the devastating effects of the root disease.

2. *Selection and disinfection of seed cane.* It has been seen that the planting of infected canes, that is, those having the leaves matted at the base, not only introduces the fungus throughout the field, but does it in such way that the plant stools readily become infected. To avoid this is important. Sound cane only should be used in planting. Non-infected seed cane may be secured in two ways: (1) By careful inspection of cane for planting with the rejection of all suspected ones. (2) By thorough disinfection with some good fungicide, such as Bordeaux mixture. Of these two methods the former is less expensive, but is probably less effective, since there is always a chance that some very slightly infected stalks will be overlooked. Both methods are tedious and costly when carried out on a plantation scale. But by setting apart a tract of superior land that is free from root fungus infestation, for growing seed cane, and by careful selection and perhaps disinfection of the seed cane for the general planting can be obtained at a minimum expense.

2. *Resistant varieties.* All the evidence now at hand shows greater freedom from root disease in the case of the seedling varieties D 74 and D 95. Exact statements regarding a possible natural resistance to the disease possessed by these must be deferred until tests now in progress yield results. In any event, there is a certain amount of present benefit as regards freedom from root disease to be derived from the planting of the new canes.

4. *Destruction of infected trash.* The mycelium of the root disease fungus lives over from season to season in the dead and decaying parts of affected canes that are left in the field. These are an important source of infection to the new crop. Burning over the fields destroys much infected trash; and this practice, as well as the removal as thoroughly as possible of old cane stumps, tends to hold the root disease in check.

5. *Resting land from cane.* In some instances the root disease fungus has become so thoroughly distributed and so well established in particular fields as to render the operation of the foregoing measures inadequate for a proper control of the

disease. The application of fungicidal substances to the soil over large tracts has generally proved unsuccessful for the eradication of fungi which live in the soil and attack the underground parts of plants. It is not likely that any degree of success would attend the use of such substances in the present case. Since there is no evidence that the sugar cane *Marasmius* has any other plant than sugar cane for a host plant, it is reasonable to suppose that the amount of its persisting in the soil can be materially reduced by keeping cane off the land for several seasons. The usual rotation covering a three or four-year period, doubtless has its beneficial effect in lessening the amount of root fungus in the soil. Unfortunately, data are too incomplete for anything to be said about the length of time necessary for the complete eradication by this method of the fungus from a badly infested field. Frequent plowing for the purpose of thoroughly exposing the soil to the sun and drying it would doubtless destroy much of the fungus. The stubble crops are not only the ones in which the greatest losses occur, but they are the ones that best serve as nurseries for the fungus. When the plant crop on any area is so badly affected by the root disease as to make the margin of profit dangerously small, it should be borne in mind that the stubble crop will show even worse effects of the disease, and that the keeping of the land in cane for a second season under the circumstances will increase the chance for serious infection of subsequent cane crops; and the matter of leaving the stubble or planting an entirely different crop should be decided in the light of these considerations.

Success is attending the use in other countries of the measures mentioned. A recent letter from Dr. H. C. Prinsen-Geerligs conveys the information that it is now difficult to find specimens of the root fungus in Java. The system practiced there of quick rotation with the elimination of the stubble crops, and the great care taken with the material for planting, have no doubt played an important part in bringing about the results. The work of control in the Hawaiian Islands has been too recently undertaken for definite results. Published accounts of late date from the British West Indies indicate that careful cultivation, rotation of crops, selection of sound seed cane, and the choice of disease resistant varieties, are measures that are being used there with an encouraging degree of success.

TECHNICAL DESCRIPTION.

Specimens of the Louisiana root disease fungus have been submitted to Dr. W. G. Farlow, who has very kindly examined them, and has expressed the opinion that they are to be regarded provisionally *Marasmius plicatus,* Wakker. Since it has not been possible to make comparison with a specimen of this species, it has seemed advisable to include the following technical description of the Louisiana fungus:

Pileus 12-35 mm., usually 15-20 mm., across; flesh thin, somewhat pliant; convex with the margins somewhat incurved, then expanded and more or less depressed; even, glabrous, at length rugose and wrinkled; whitish, becoming tawny when dry. Lamellae adnexed, sometimes joined behind and leaving the stem; distant, unequal, often connected by veins, rather broad, thin, even, white. Stipe stuffed, then hollow, fibrous inside, with a cartilaginous cuticle, almost glabrous above, base tuberculose and flocculose; whitish, 5-20x0.8—1.8 mm., usually 12x1 mm. Spores white, ovate, and with a prolongation at the attached end, 6.8x5.6 mm. Mycelium whitish to cream color, flocculose becoming cemented by gelatinous envelopes, sparingly septate, with clamp connections, about 3 mm. in diameter. On leaves, roots and decaying parts of sugar cane, having the habit of a weak parasite. Greparious, scattered or somewhat cespitose.

The sporophores are shown in Figs. 2 and 3; the spores in Fig. 7, and the mycelium in Fig. 8.

EFFECT OF TEMPERATURE ON GROWTH.

In testing the effect of different temperatures upon the mycelium of *Marasmius plicatus,* cultures in test tubes on slightly acidulated potato agar were used. The exposures were made when growth was well started, that is, 20 to 30 hours after inoculation; but in a few instances cultures four or five days old were tested without showing important difference from the younger cultures. The more important results are given below:

Exposure.	Temperature degrees C.	Growth during exposure.	Growth after exposure.
6 hours	—10 to —16		None. Dead
½ hour	—10 to —16		Fair
6 hours	0		Good
5 days	3 to 5	None	Good
5 days	11	Slight	Excellent
5 days	20	Good	Excellent
5 days	25	Excellent	Excellent
5 days	30	Excellent	Excellent
5 days	35	Good	Excellent
5 days	41 to 42	None	None. Dead
6 hours	45		Good
2½ hours	50		None. dead
1¼ hours	50		Fair
¾ hour	52		Fair

RESISTANCE TO DRYING.

When plugs of sugar cane from test tube cultures nine to ten months old and thoroughly air dry were placed in moist chambers, growth was secured in about one-fourth of the trials. The fungus was also recovered from the mycelial growth well up on the sides of flask cultures of a like age, with steamed rice as culture medium. A cane stalk that had remained for ten months in the rather dry laboratory atmosphere yielded a good growth from detached portions of the matted leaf sheaths.

CONDITIONS FAVORING FRUITING.

Before fructifications were found in the field various attempts were made to secure them from pure cultures. For this purpose six strains of fungus were grown in flasks on a wide range of nutrient media and under varied conditions of temperature and moisture. The mycelial growth was very much the same in all cases, and nothing suggestive of sporophore formation was apparent. The first fructification seen was found in June on a cane plant grown in a tub and naturally affected with root disease from the infected cutting planted. The lower part of this stalk had been covered with a glass cylinder pushed into the ground and plugged at the top with cotton, so that the atmospheric conditions about the sporophore were rather moist. On August 4th, after several days of cloudy weather, with intermittent showers, the fruit-bodies were found in great abundance on several plantations examined, and their constant association with the mycelium cementing the leaf sheaths was definitely determined. They were also found on detached pieces of decaying cane that were permeated with typical *Marasmius* mycelium, and on exposed broken roots of still living cane stools, the roots also being filled with the mycelium. From this time until the last of September it was possible to find fruit bodies whenever conditions were sufficiently wet in the cane rows, and not during drier periods. The fruit caps were usually found on the bases of the stalks within an inch or two of the surface of the ground, where the leaf sheaths were quite moist. Careful search during October and November, when moisture conditions seemed favorable, was unsuccessful. It would seem probable that rather high degrees of moisture and warmth are required for fruiting.

INOCULATION EXPERIMENTS.

In the first series, which included about twenty plants, cane-cuttings were sprouted in damp moss, and transferred to tubs filled with clean sand. Mycelium of three strains from pure cultures was used for inoculation material, and was placed in contact with the young sprouts at the time of setting out. The plants were watered with Sachs' nutrient solution. These inoculations were successful in three-fourths of the trials.

The second series was with young cane in the field several weeks before it began to joint, and while the lowermost leaf sheaths were apparently in a living condition. The inoculation material was from pure cultures of two strains, and was applied variously above the ground, below the ground, to uninjured sheaths, to incised sheaths, and in some cases with protection from drying by means of paraffined pasteboard cylinders, and in other cases without such protection. After two weeks, during which period weather conditions happened to be most favorable, every inoculation had taken.

After fructifications had been secured, successful inoculations were made with pure cultures from spores and from the stipe, as well as from the sheath-cementing mycelium.

In the laboratory roots were infected frequently and in various stages of development by growing them in moist chambers and placing portions of agar cultures in contact with them. Natural infection of the roots was secured readily by keeping nodes that were well covered by the adhering leaf sheaths in moist chambers. Young leaves inserted in test tubes containing an abundant growth of the fungus were readily infected.

In the case of each marked external discoloration and pathological change in the outermost cells followed quickly, and only after these had taken place could the fungus threads be found pervading the tissues. The infected areas afterward spread rapidly. The mycelium had an intracellular disposition. The first foothold on roots was usually at the point of emergence from the stalk where a slight projection of dead stalk tissue furnished a good feeding ground for the fungus (Fig. 6). Next in frequency under natural conditions was entrance from the root cap. Here it was noticeable that not the growing point, but that part of the root tip covered by the proximal portion of the root cap was the point of first entrance. In the roots the cortex was the region most extensively infested, and only occasionally were fungus threads found in the fibro-vascular bundles.

In the case of leaves, entrance was not generally through the stomates, but usually by a direct penetration of epidermal cells. Both parenchymatous and vascular elements were permeated.

All indications point to the conclusion that this species of *Marasmius* gains entrance only after the outside cells of the attacked portion of the cane plant have been killed; and this killing is accomplished presumably through some physiological activity of the fungus.

Infection experiments were not made with other plants than sugar cane. In only one case was the fungus seen growing out of doors on any other plant: in a field where there was abundant evidence of considerable soil infection, two fruit-bodies were found on a dead piece of Bermuda grass, and the leaf sheath was cemented to the stem by the mycelium in characteristic fashion.

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Cobb, N. A.: Fungus maladies of the sugar cane. Hawaiian Sugar Planters' Station, Div. Path. and Physiol., 5, 1906.

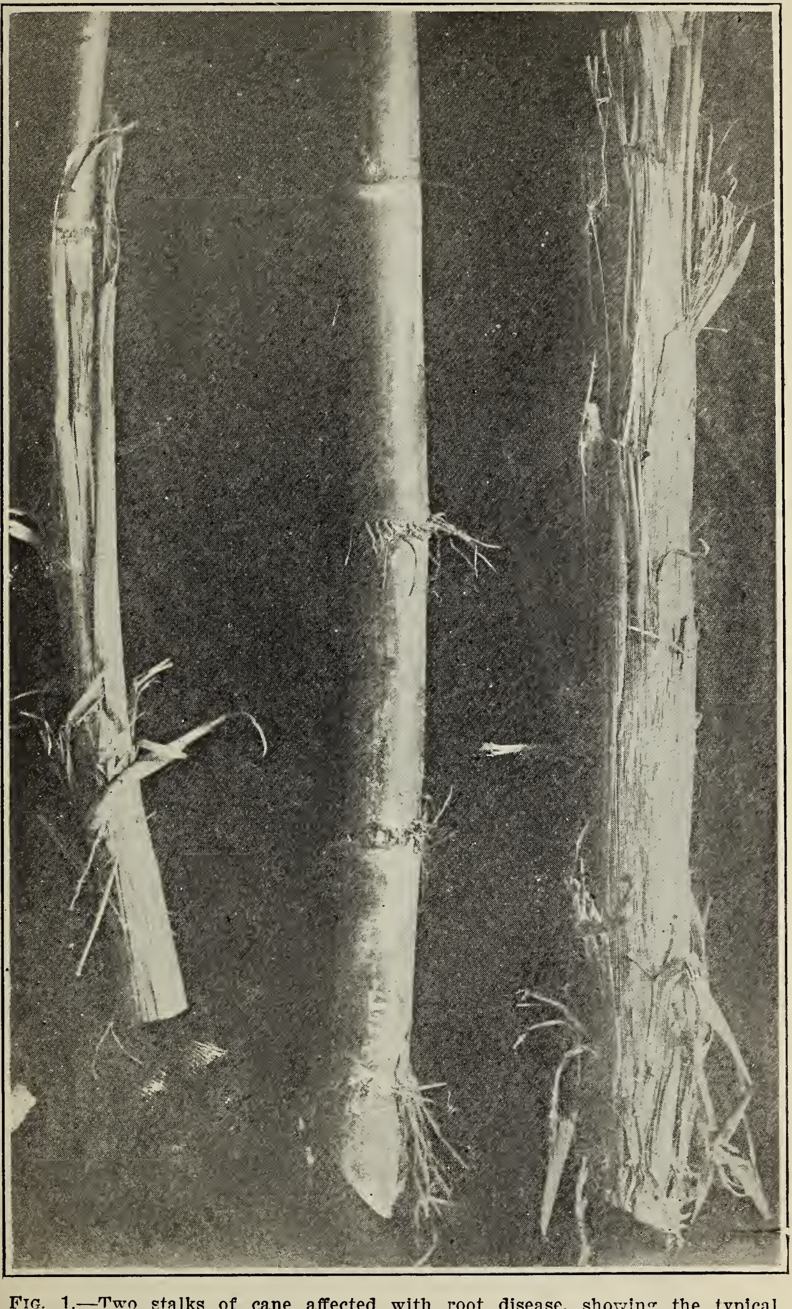

FIG. 1.—Two stalks of cane affected with root disease, showing the typical cementing of the shuck. The middle unaffected stalk is for comparison.

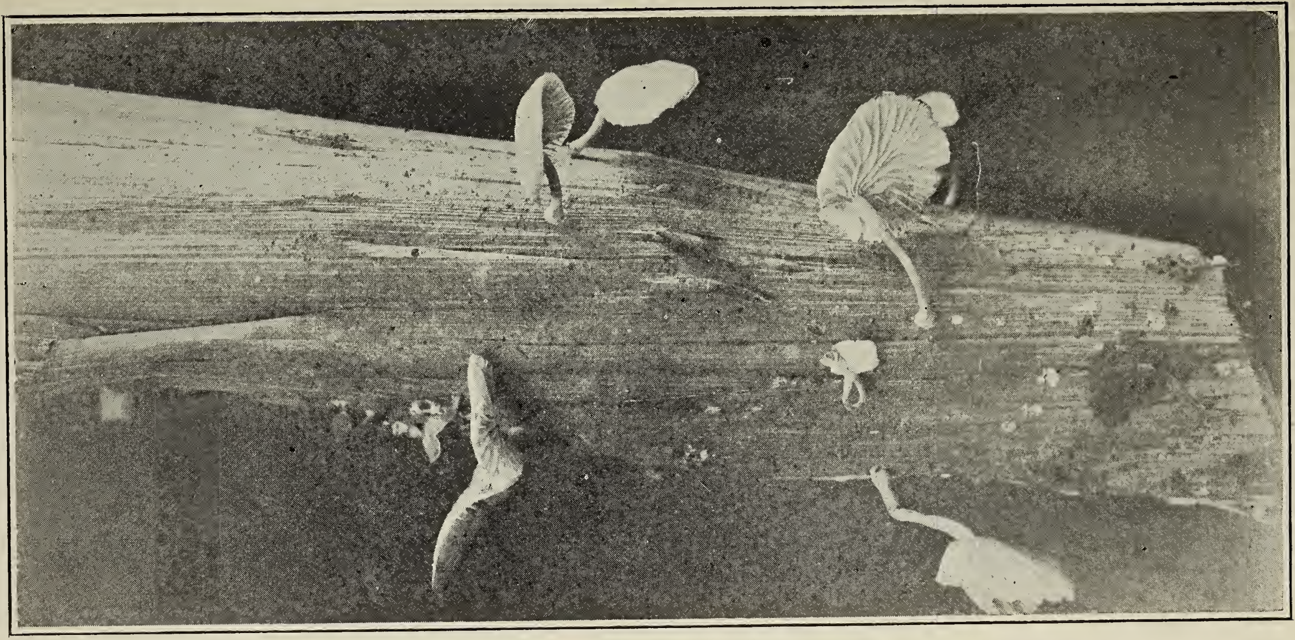

FIG. 2.—Fructifications of the fungus causing root disease of sugar cane in Louisiana, and supposed to be *Marasmius plicatus*, Wakker. x 4-5.

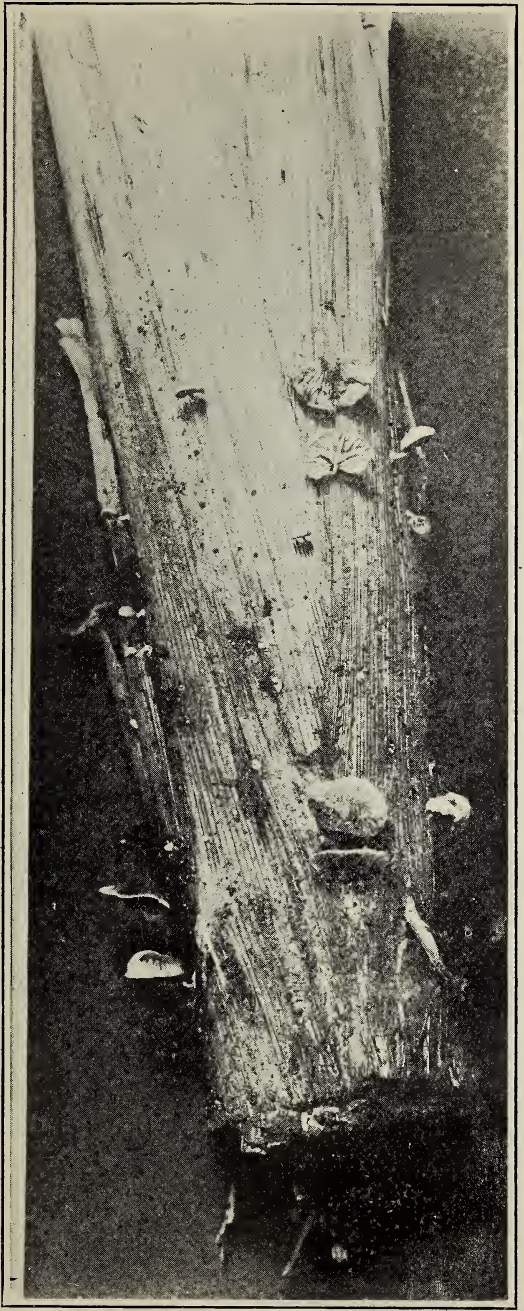

Fig. 3.—Fructifications of the fungus causing root disease of sugar cane in Louisiana, and supposed to be *Marasmius plicatus*, Wakker. x 4-5.

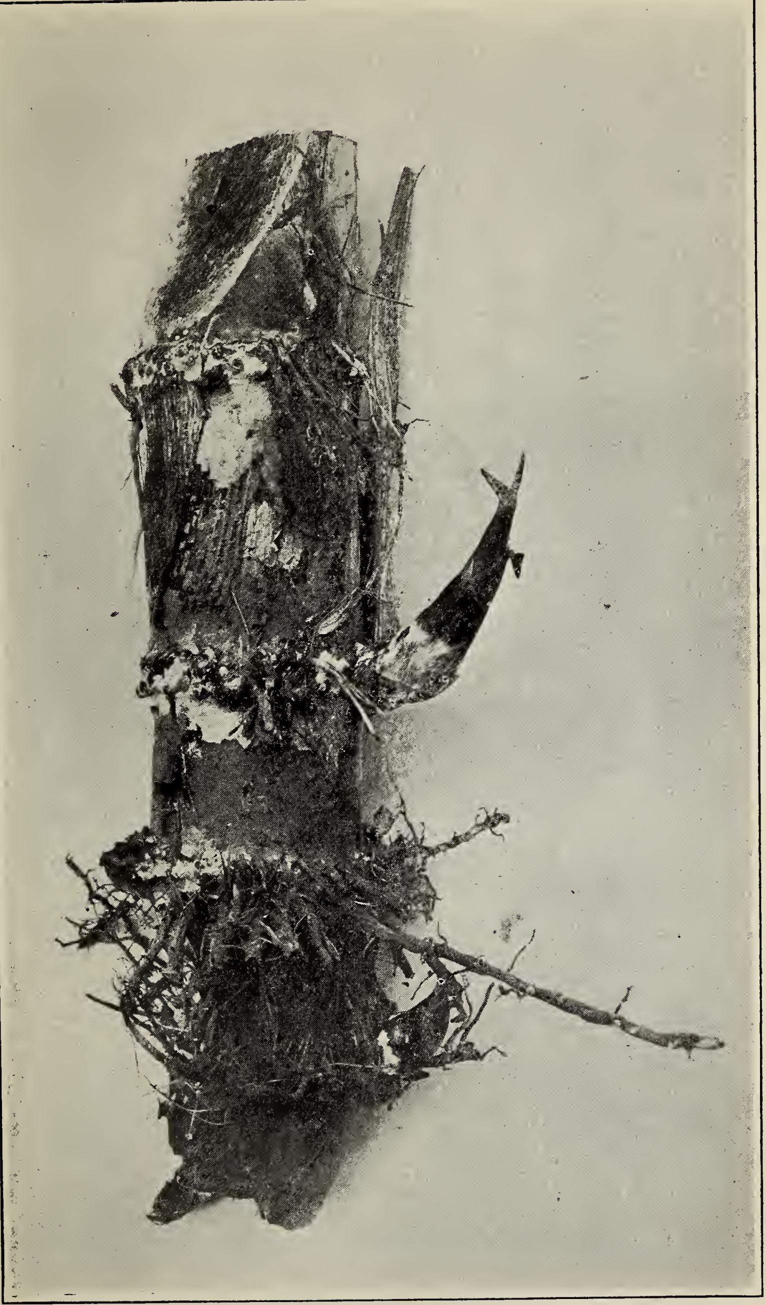

FIG. 4.—Stock of cane affected with root disease. The white mycelium is growing vigorously on the young shoots, and in the case of the long root extending to the right, white tufts of mycelium protrude from the **breaks in the bark.**

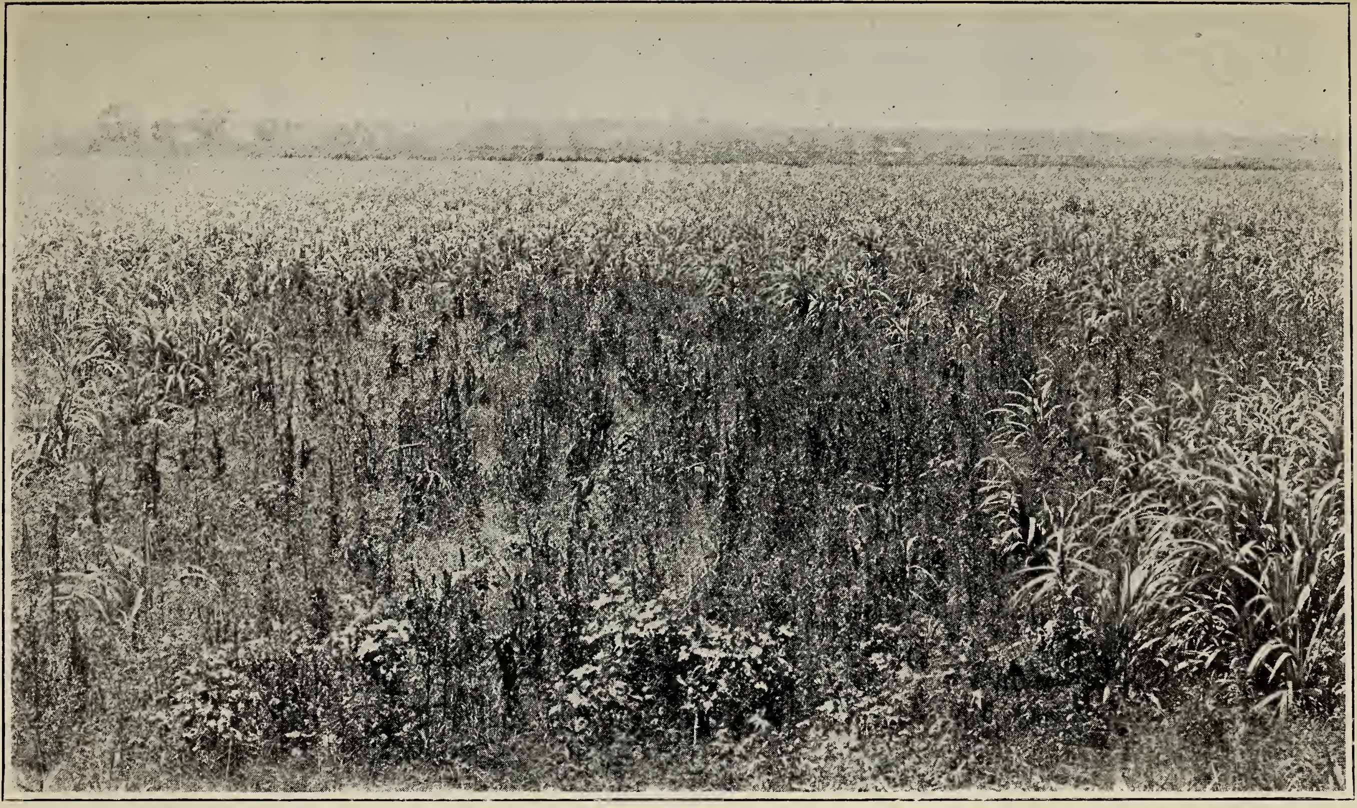

FIG. 5.—Portion of a field of stubble cane where the loss is very great. The few canes left in the affected area show the root fungus very prominently.

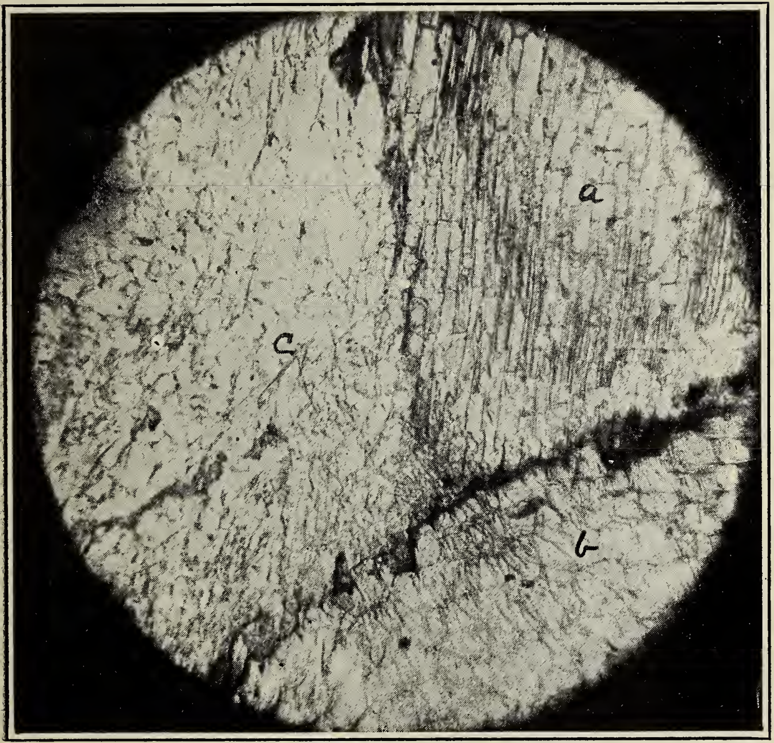

FIG. 6.—Microphotograph showing invasion of sugar cane root by the threads of the root disease fungus. *a* is a portion of the main root cut longitudinally; *b* is a root branch cut transversely; and *c* is a portion of disintegrated tissue from the mother stalk at the point of emergence, which is full of fungus threads. These are seen entering the cells of *a* and of *b*.

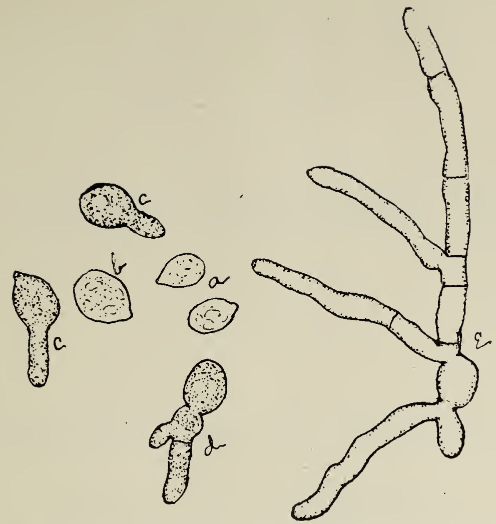

FIG. 7.—*a.* Spores of *Marasmius plicatus,* normal size. *b.* Spore swollen previous to germination. *c.* Spores in early stages of germination. *d* and *e.* Later stages of germination. x 1,000.

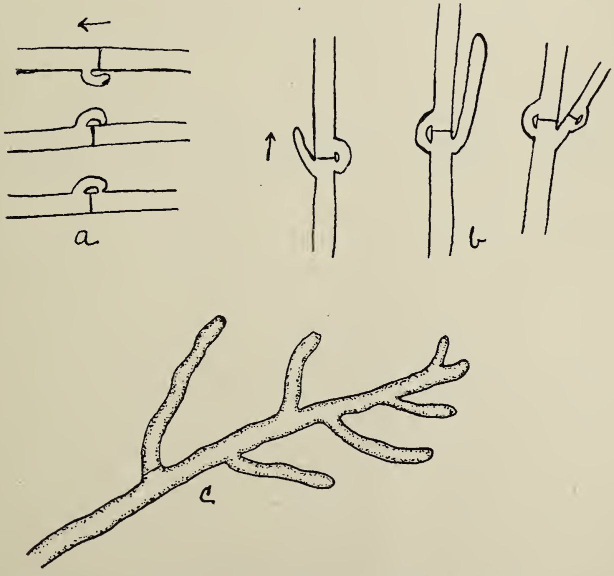

FIG. 8.—*a.* Mycelium of *Maramius plicatus,* showing stages in the formation of the clamp connections. *b.* Mycelium showing branches. *c.* An actively growing tip of the mycelium. x 1,000.

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Diseases of Pepper and Beans

H. R. FULTON, M. A.

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Diseases of Pepper and Beans.

PEPPER BLIGHT.

Symptoms. The first indication of blight or wilt of pepper plants is a slight drooping of the young leaves at the tips of branches during the day. These leaves recover at night and appear perfectly normal the next morning; but this is only temporary, and during the second day the wilting is much more pronounced than before. Usually by the third or fourth day all of the leaves are wilted beyond recovery, and change of color, drying, and dropping off follow shortly; the plant is now evidently dead (Figs. 1 and 2). Such marked wilting is the usual appearance presented by affected plants, but from time to time some are met with that show the yellowing and dropping of the leaves without very evident previous wilting.

If a plant in the early wilting stage of the disease is pulled up, the roots generally are seen to be sound and in good condition; but there is apparent on the stalk a little below the ground level, or perhaps on one of the larger root trunks, a shrunken, discolored area of variable size, usually extending a considerable distance around the stem (Fig. 3). At a somewhat later stage, when defoliation has begun, this area is seen to be larger, more sunken, and more discolored; and in its central portion the bark is in process of disintegration. The wood under such a lesion is apparently unaffected. From this time forward, rotting of the roots lower down may set in and progress rapidly.

Attacks commence when the plants are beginning to form pods, and usually continue until the end of the growing season. There is much evidence of spread from affected plants to adjacent sound ones; this takes place through the soil, as will be seen.

Cause. If the abnormal areas found on the stems just below the surface of the ground, be examined carefully, there can be found permeating the bark and usually spreading over its surface, the fine white threads of a fungus growth (Fig. 6). If such a part of the stem is placed in a covered dish where a high degree of moisture is maintained, there will appear in the course of twenty-four hours a very abundant growth of the fungus. By exercising proper care portions of this fungus can be transferred to sterile culture media and made to grow entirely separate from other organisms. In this way it has been found that one particular fungus is always associated with the characteristic lesion of pepper blight; and further, that when pure cultures of this fungus are placed in contact with the stems of a sound pepper plant, symptoms of blight appear in three to five days, and the disease runs a typical course, resulting in the death of the plant. The fungus can always be found again in the lesions of such artificially infected plants.

There is no doubt then that the attack of this fungus is the primary cause of the blight of pepper plants. The bark and soft cambium tissue between it and the wood are destroyed; and when this destruction extends around the stems the plant is as completely girdled as though the operation had been performed with a knife. Of course the plant cannot survive such injury, and the wilting and dying of leaf and stem is the expected result of the serious interference with its nutrition. The later decay of the roots is a secondary phenomenon resulting from the attacks of various saprophytic soil organisms.

The fungus. The great majority of fungi have a vegetative part, the mycelium, which produces special propagative parts, the spores; very much in the way that higher plants have a vegetative part consisting of roots, stems and leaves, and special propagative parts, the seeds. The most striking peculiarity of the fungus under consideration is that it does not produce spores in so far as is known. Its increase and spread seem to be accomplished entirely by new growth from vegetative parts in a way that corresponds to propagation by cuttings in the case of higher plants. The spores of fungi, in many instances, have powers of resistance to cold and dryness that are much greater than those of the mycelium, and that make it possible for the fungus to survive unfavorable conditions that would otherwise prove completely destructive.

The pepper blight fungus, although apparently without spores, has the ability to form dense mycelial masses known as sclerotia, which have thick coverings and can withstand conditions of temperature and moisture that would destroy the delicate, thread-like mycelium. In the case of the pepper wilt fungus the formation of sclerotia is made evident by the appearance of white tufts or flecks of mycelia; these gradually assume a larger and definitely rounded form and become hard and smooth externally. The color changes from white through the lighter shades of brown to very dark brown; the size is that of an ordinary pinhead or a little larger; the shape is spherical or nearly so (Fig. 4).

The lack of knowledge of the spores prevents definite classification and naming of this fungus, since these matters depend so largely on the character of the spores. However, its straight, radial habit of growth is rather distinctive; this and the presence of the small, smooth, brown sclerotia render the recognition of the fungus easy. It is possible, of course, that further study will reveal physiological or morphological differences on the basis of which separation will be made into species or varieties. In the only accounts of the disease that we have seen, which are those by Professor P. H. Rolfs of the Florida Experiment Station, the view is held that the fungus is the same on a wide range of plants, cultivated and wild. In the present study of the fungus, all indications have pointed to the same conclusion.

Prevalence and destructiveness. Pepper blight was first reported from Florida in 1893. It has existed in Louisiana for a considerable time, and has been seen by the writer in a number of widely separated localities in the State. The losses occasioned by it seem to depend largely upon seasonal and other variable conditions. Loss from it is frequently considerable, as much as twenty-five to fifty per cent.; in other seasons it is slight or nothing at all. The writer has seen peppers in a garden patch fully ninety per cent of which were destroyed by this disease. There is much to indicate that the fungus tends to become more abundant in the soil from year to year.

From Florida the pepper blight fungus has been reported as attacking many other plants, including tomato, eggplant, Irish potato, sweet potato, beet, peanut, beans, cowpeas, cabbage, squash, watermelon, rhubarb, fig, cotton, violets, hydrangea, daphne, chrysanthemum, morning glory, beggar weed, fire weed, Canada fleabane. The writer has observed it in Louisiana attacking pepper, bush and pole beans, and the Japanese fiber plant *mitsumata* (*Edgeworthia papyrifera*) (Fig. 5); it has also been found on the decaying parts of various plants such as cotton boll, fig fruit, grass, cauliflower and tomato leaves, in all cases when these were in contact with the ground. It is also quite common on the leaf sheaths of sugar cane, especially at young stages; the sheaths when affected show a distinctly red discoloration. A similar condition has been described from Java by Dr. J. H. Wakker, and his plates bear a striking resemblance to what is found on the cane in Louisiana. The writer has not found cane to be seriously affected by the fungus; in Java it is reported as causing a disease known as "red mucus" (*Roten Rotz*), which is to some extent injurious to young cane plants.

It is thus seen that the fungus which causes the blight of pepper is of especial importance because of the large number of plants, many of them valuable ones, that may be attacked by it.

Means of prevention. From what has been indicated regarding the nature of the injury caused by the fungus, it will be appreciated that little or nothing can be hoped for in the way of cure when once a plant shows signs of blight. And further, since this fungus lives in the soil and attacks the plants on underground parts, no good can be accomplished in the way of prevention by the application of fungicides to the foliage.

Treatment that has been demonstrated to be successful is the application of a clear fungicide such as ammoniacal copper carbonate, or eau celeste, to the ground just at the base of the plants in such a way that it may soak into the ground for five or six inches from the stem and cover the stem itself for some distance; branches that touch the ground should be coated at the place of contact. The solution should be applied with some sort of spraying apparatus, and about a pint used for each pepper plant of good size. The first application should be made as soon as careful watch shows the first indication of blight; or, if blight is expected, it should be made while the plants are in flower or a little before. Other applications should be followed every two or three weeks. By this means the part of the plant most subject to attack is very effectively protected. The precipitate in Bordeaux mixture is filtered out by the upper part of the soil; on this account this very excellent fungicide is for the present purpose inferior to the ones mentioned. Formulas for these are given at the end of this bulletin. Unfortunately for some experiments which were planned along these lines, there was too little blight of pepper during the last season for definite conclusions to be drawn from them. There was, however, a severe outbreak among the Japanese fiber plants, and it was found that such treatment protected these appreciably, although the trial was made under very severe conditions.

It has been a prominent characteristic of the fungus that it will not grow on nutrient media unless they have a comparatively high degree of acidity. This suggests that the fungus may find conditions best for its growth only in soils that are more than ordinarily acid. If this is really the case, the use of lime to reduce the acidity of the soil ought to have a good effect in reducing the loss from blight. It is hoped that it will be possible to make some tests along this line at an early date.

Rotted vegetable matter, because of the good feeding ground it furnishes, is likely to become thoroughly permeated with the fungus if any of it is introduced; and the common prevalence of the fungus renders such a thing rather probable. Such material may efficiently spread infection to growing plants.

Inoculation experiments. Inoculation of healthy pepper plants with pure cultures of the peculiar sclerotium-producing fungus has always been followed within a few days by typical symptoms of blight (Figs. 1 and 2). In the first series of experiments removal of the soil and sometimes slight abrasion of the bark were resorted to in making the inoculations. It was found later that infection followed just as readily when the culture material was merely placed on the surface of the ground in contact with the stem and covered with a little earth and watered. Cultures applied above ground to single branches of pepper plants produced the usual lesions at the points of application, and was followed by characteristic wilting of the branches in question. In these cases the parts were cleansed with weak carbolic acid and steriled water, and a wrapping of moist sterilized cotton placed over the inoculation material from a pure culture.

After these preliminary tests, which demonstrated the parasitic nature of the fungus, it was thought proper to ascertain (1) whether all varieties of pepper are susceptible to infection, and whether equally so, (2) to what extent other plants of economic importance are susceptible to infection by the fungus causing blight of pepper plants, (3) to what extent strains of the same or a similar fungus from other sources have the ability to infect plants of various kinds. Until now it has not been possible to carry out anything more than a very preliminary set of experiments along these lines.

By careful inoculation tests the following varieties of pepper were found to be susceptible to infection by the fungus obtained from bligthed pepper: Ruby King, Monstrous, Cayenne, Bell, Cluster, Red Cherry, Tabasco, Celestial, Chinese Giant, Chili, County Fair, Neapolitan. These were all the varieties tested. All the individual plants inoculated became infected except in the case of the Red Cluster variety; here only one out of three inoculations was successful; the test unfortunately could not be repeated. In 1906 a row of Red Cluster pepper was observed to suffer only slightly, while the adjacent rows of other varieties were almost completely destroyed by the blight. Naturally infected plants of Sweet Spanish and Upright Sweet Salad have been seen.

The sclerotium-producing fungus from pepper was found to infect pole and bush beans, tomato, eggplant, and the Japanese fiber plant, *Edgeworthia papyrifera;* but not okra, although attempts were made at three different times.

Pepper plants were infected by strains of the sclerotium-producing fungus from the following sources: pepper plant, tomato leaf, cotton boll, sugar cane leaf sheath, fig fruit, cauliflower leaf, bean pod, Japanese fiber plant.

Japanese fiber plants were infected by the fungus from Japanese fiber plant, pepper plant and bean plant.

Bean plants were infected by the fungus from bean plant, pepper plant, and sugar cane leaf sheath.

Okra failed of infection by the fungus from pepper plant, sugar cane leaf sheath and cotton boll.

BEAN DISEASES.

In all some ten or twelve diseases of beans have been recognized in the United States. Two of these, pod spot or anthracnose, and bacterial blight or bacteriosis, are of the utmost importance because of their common occurrence and great destructiveness. Two of the minor diseases, a pod and stem rot caused by the fungus *Rhizoctonia,* and a blight or wilt caused by a certain sclerotium-producing fungus, are probably little known, and deserve somewhat more extensive treatment than they have received. These four diseases will be discussed in this writing.

ANTHRACNOSE OR POD SPOT.

This well-known disease is caused by the attacks of a parasitic fungus known technically as *Colletotrichum lindemuthianum,* which is closely related to the several species of fungi causing the anthracnose of cotton bolls, of cucumber, watermelon and cantaloupe, of tomato, of alfalfa, and of lemon, lime, and orange. Anthracnose affects all varieties of kidney beans, the wax varieties to a greater extent than the green-podded ones.

The most conspicuous effect is the spotting of the pods, and from this come the names pod spot and anthracnose, the latter having its derivation from the Greek word meaning ulcer. A third name commonly used for this disease is "rust"; but such usage is to be condemned because the bean is subject to a true rust caused by a fungus belonging to the same general group of fungi as those causing rust of oats, of the fig, of the dewberry, etc., which produces small, brown, powdery pustules on the leaves of beans, but not usually on other parts of the plant. To use the term rust in a loose way to indicate the anthracnose of beans simply creates unnecessary confusion.

The spots on the pods appear at first as small, light brown areas which gradually become larger, darker and distinctly sunken (Fig. 7). Typically, the spots are circular, but neighboring ones may coalesce, giving rise to very large irregular affected areas. These spots are caused by the growth just beneath the surface of the pod of the thread-like mycelium of the anthracnose fungus; this draws its nourishment from the cells which compose the pod tissue, and in doing so destroys them. At a proper period in its growth the fungus begins to fruit. This it does by sending up from a mass of the mycileum a number of palisade-like branches which break through to the surface and produce at their ends the spores (Fig. 8). These are elongated bodies of microscopic size which can germinate and reproduce the anthracnose fungus (Fig. 9). They are produced in very large numbers, and may be seen in the centers of well-developed spots as pinkish masses hardly visible to the unaided eye; each such mass is made up of tens of thousands of spores. Each spore is surrounded by a gelatinous envelope, which when dry glues it to its neighbors; when moistened the spores readily separate, and the envelopes serve again as means of attachment when they come in contact with a new object. This indicates something of the reason for the spread of pod spot when there is moving about among the vines while they are wet. A spore that reaches a fresh pod of the bean plant will germinate if conditions, especially of moisture, are favorable; and the minute thread of the new fungus plant will penetrate into the tissues, cause their disintegration, and thus produce the external symptoms that indicate a new affected spot. Such indications are not apparent until the fungus has become well established within the tissues, too well established for eradication without serious or fatal injury to the plant itself.

The spread by spores, while the most extensive, is not the only way in which this fungus is propagated. If a badly affected pod be examined, it will be found that the seeds lying directly under the spots are apt to be discolored and to show upon themselves shrunken areas similar to those on the pod. This means that the mycelium of the fungus has worked its way through the entire thickness of the pod hull and has entered the seed. As the seed ripens and becomes dry, the fungus within it ceases to grow; but it does not die. Conditions of warmth and moisture that cause the germination of the bean have a like effect upon the anthracnose mycelium within its tissues. And so it comes about that the bean seedlings as they come up, have brown sunken areas on the seed leaves or the stem in which the fungus is actively growing. Sometimes this early infection is so severe as to kill the seedling and ruin the stand; but usually it is not prominent enough to be noticed. Very soon masses of spores are formed in the affected spots, and these spread the infection to the leaves and stems of the rapidly growing plants. Here, too, the lesions may be apparent only on close inspection. On the leaves they appear usually as reddish or blackened areas along the large veins on the under surface. Spores are formed in turn in these areas and continue the dissemination of the fungus. When the pods begin to form, there is already present in the field an abundance of spores; and the first observed spotting of the pods is not by any means the beginning of the infection. That goes back to the time of planting, and was brought about by the use of seed which had the living anthracnose fungus in them.

Sometimes serious trouble is caused by the spotting during marketing of beans that were apparently sound when picked. From what has been said, it can be readily understood that such beans may have been affected just before picking, or during the picking, sorting and packing. The handling of one affected pod may result in the infection of many others handled subsequently.

Weather conditions have much to do with the prevalence of the disease in any particular season. Warm showery weather is most favorable for it; heavy dews and fogs also furnish suitable conditions for its spread. Very dry conditions have the opposite effect, and may be so effective that the destructiveness will not be great even though infection is present from the first.

MEANS OF CONTROL.

Seed selection. From what has been said it is evident that the planting of non-affected seed is a most important factor in the control of bean pod spot. Since the disease is widespread, occurring in every section of the country, the mere getting of the seed from a distant point does not insure its freedom from infection. The presence of the fungus in seed is indicated by a brownish or yellowish discoloration of their coats; and by inspection it can be told whether a lot of seed is badly infected or probably free from infection. Much could be acomplished by going over the seed carefully before planting and rejecting all that show discoloration or abnormalities of all kinds. There are on the market certain so-called "rust proof" varieties of beans which are supposed to possess a high resistance to pod spot; reports from elsewhere, and the observations of the writer indicate that while there is a difference in the susceptibility of the different bean varieties to anthracnose, there is not one of them completely immune. Seed are also on the market for which the claim is made that the fields in which they were grown were entirely free from anthracnose. No superior resistance is claimed; the merit lies in the absence of seed infection. The writer made the attempt this season to test such seed, as well as seed from a number of other sources. While a greater freedom from infection of seedlings was noted, the test was not as definite as could be wished, because the weather conditions were such that the anthracnose did not affect the plants of any lot to any extent during the later stages of their growth; but bacterial blight was abundantly present and greatly interfered with the experiment.

Removal of affected plants. This refers particularly to diseased seedlings as soon as they can be detected. They should be pulled up and burned. At the end of the season all stalks and leaves in any infected field should be collected and burned to prevent the renewal of infection from them the following season.

Rotation of crops. It is a good practice in combating bean anthracnose, to avoid planting the same area successively in this crop.

Care in cultivating, picking and marketing. In so far as possible the working and gathering of beans should be avoided while the bushes are wet with dew or rain. Affected pods should not be picked, washed or packed with sound ones. Containers should be such as to allow good ventilation, and should be stored in as dry and cool places as possible.

Spraying. This is a very efficient means of keeping the disease in check if carried out thoroughly. The object of the procedure is not to accomplish the impossible task of removing the fungus from already affected plants; but it is to protect unaffected plants and parts of plants from infection by spores that may happen to reach them. These cannot penetrate into the tissues if they are coated externally with a good fungicide. This must evidently be applied so as to cover all vulnerable parts of the plant, and must be renewed as often as may be necessary for this purpose. A somewhat weak Bordeaux mixture, the 5-4-50 formula, is suitable for beans. The first application should be made to the seedlings as soon as the first true leaves have unfolded. A second one should follow in ten days or two weeks. The object should always be to cover thoroughly all parts of the plant above ground. A third application for the special protection of the pods should be made just after blossoming, while the pods are forming. Ordinarily three applications should be sufficient; but if the season is unusually wet, or infection very great, another spraying should be made between the second and third, and still another when the pods are nearly full-grown. Even if the earliest sprayings have not been made, much good can be accomplished in protecting unaffected pods by a thorough application to them after spotting has become apparent in the field.

BACTERIAL BLIGHT OF BEANS.

Bacterial blight of beans, or bacteriosis, is caused by a species of bacterium known as *Pseudomonas phaseoli*, which attacks both kidney and Lima beans. These particular bacteria or germs are short rods about twice as long as broad, that are found in the stems, leaves and pods of the affected plant. They are of such very small size that they can be seen individually only with the highest powers of the microscope. Each of these very minute individuals is a living plant, and has the power of growth and reproduction; this last it accomplishes by simply dividing into two. So rapidly do the generations follow each other under favorable conditions that the descendants of a single individual may number many millions in the course of twenty-four hours.

The most marked effect of the disease is to be noted on the affected leaves (Fig. 10). On these the invaded areas are seen at first as small spots of yellowish color and water-soaked appearance; these increase in size until the whole leaflet is involved. The central, or the first invaded portion, of a large affected area consists of brown, dry tissue which may or may not furnish a feeding ground for a miscellaneous lot of saprophytic fungi. Beyond the central dry portion is a zone of dead leaf tissue not yet brown and only partially dry; beyond this is the most recently invaded portion of the area, which has the greenish-yellow, water-soaked appearance of the first stages. All parts of the affected area are traversed by dark lines of irregular course, which mark the boundary of successive stages in the spread of the bacteria to new portions of the leaf. These lines are more apt to have a broken course, including polygonal areas, than to take the form of concentric circles. This seems to result from the temporary limiting of the spread of infection by the larger veins of the leaf. Affected leaflets usually remain attached to their stalks until they die and shrivel. Later the ends of the leaf stalks shrivel and become dry; and ultimately the infection may extend to the branches and through these to other leaves and to pods (Fig. 11). The diseased areas frequently begin at the margins of the leaves, or where the tissue has been torn by insects or in some other way.

The lesions on the pods are somewhat less conspicuous than those on the leaves (Fig. 12). The usual appearance is that of a circular spot, neither raised nor sunken, water-soaked and brownish-yellow, without a very sharp boundary. The spots vary much in size, and are less regular in outline and more elongated when the edge of the pod—the "string"—is involved. On the surface of the spots are particles of dry yellow gum, just visible to the eye, which are exuded masses of the bacteria that cause the lesion. If a spot is cut across, and the hull pressed between the fingers, a small quantity of the fresh gummy material can be forced out. If a small portion of this be taken up on the point of a needle and introduced into a sound pod or other part of the plant through a slight prick, there will appear after a week or two symptoms of bacteriosis about the new center of infection. A similar transfer of the medium of contagion is probably accomplished very extensively through the agency of insects that feed upon the bean plant.

Sometimes the spots on the pod assume a deeper brown and sunken appearance because of secondary invasion of the diseased areas by saprophytic organisms. But there is never a close enough resemblance to the spots of anthracnose to occasion any confusion.

When the bean plant is severely attacked at a number of points, the normal processes of nutrition are greatly interfered with, and there results a general wilting and shriveling of the younger pods. The seeds in contact with affected areas of the pods become infected with bacteria; but there are not always such marked external indications of this as would enable one to pick out affected beans from a mixed lot with any degree of thoroughness. That the bacteria are present can be determined by microscopical examination, or by following procedures for securing them in culture from the seed tissues. By the latter means these bacteria have been found to remain alive for a number of months; and in this way, through the seed, infection may be carried to a new crop of beans in the same general way as anthracnose may be.

PREVENTION.

Good Seed. Inspection of seed with rejection of infected ones, while desirable, is not wholly practicable because of the impossibility of detecting them with certainty. It would be well to secure, if possible, seed grown in fields free from bacterial blight; but the caution must be given, as in the case of anthracnose, that the disease prevails over a large part of the country.

Seed treatment. The bacteria causing the blight of beans are killed by exposure for ten minutes to water having a temperature of 122 degrees Fahrenheit. Beans will endure a much higher temperature for a longer time without injury, if they are kept dry. The writer has kept beans for 45 minutes at a temperature of 135 degrees Fahrenheit, without any appreciable effect on their germination. Seed placed in water during a like exposure are practically all killed. This suggests that bacteria possibly present in suspected seed might be killed by subjecting the seed to a proper degree of heat. To test this a lot of seed was divided into two parts, and one of them was kept at 131 degrees Fahrenheit for 45 minutes. The two lots were planted in separate rows and closely watched. No difference at any time could be noted in the amount of bacterial blight in the two rows. Of course a single test of this kind is not conclusive, and the practice is not yet to be recommended.

General measures. Destruction of affected trash and rotation of crops are important. The bacteria can live over at least one winter in stems and leaves left on the ground. Since insects are instrumental in spreading the disease, all means that serve to keep them in check are useful in the control of the blight.

Spraying. Bacteriosis is rather more difficult to control by spraying than is anthracnose; but satisfactory results can be obtained by increasing the number of applications to five or six. During the season of 1907 the writer obtained in the case of a number of varieties an average benefit of 20 per cent from spraying, four applications being given; climatic conditions were very favorable for the development of infection, and it is believed that a more satisfactory result would have been obtained with more frequent applications.

Varieties. Varieties of beans show a difference in their susceptibility to bacteriosis when planted under similar conditions. Whether this is due more largely to differences in inherent powers of resistance to the disease than to differences in the condition of the lots of seed, is an open question. During the past season the writer found that a number of varieties of bush beans took the following ranks with regard to susceptibility to bacteriosis, the least susceptible being placed first in order, and the most susceptible last: (1) Schindler's Round Pod Wax, (2) Refugee Wax, (3) Burpee's White Wax, (4) Grenell's Rust Proof Golden Wax, (5) Wardwell's Kidney Wax lot 1, ((6) Dwarf German Black Wax, (7) Early Valentine, (8) Wradwell's Kidney Wax lot 2, (9) Wardwell's Kidney Wax lot 3.

Wardwell's Kidney Wax lot 1 and Wardwell's Kidney Wax lot 3 were from the same original package; the former seed was selected for freedom from discoloration and other abnormalities, and the latter was the rejected seed. Wardwell's Kidney Wax lot 2 was from an entirely different source.

FUNGUS BLIGHT OF BEANS.

This disease of beans is caused by the same sclerotium-producing fungus that is responsible for the blight of pepper plants. The symptoms in the two cases correspond. There is first a wilting of the leaves in the sunshine, with temporary recovery at night, then a yellowing and drying, followed by a droping of the leaves (Fig. 13). The attacks of the fungus are upon the underground parts of the plant, usually upon the stem just below the surface of the ground. The fungus invades the bark as far as the cambium, destroying it, and from this results the fatal interruption of the nutritional processes of the plant.

The fungus itself has been described rather fully in the account of pepper blight which has already been given. It is characterized by mycelium that has a straight, radial growth and produces small, smooth, brown sclerotia (Fig. 4).

The means for control are those that have been suggested for the pepper blight. They are such general measures as the destruction of affected plants as soon as they can be detected, and of all possible trash at the end of the season, and the practice of a rotation of crops that will bring in non-susceptible plants. Special control consists in the application of some clear fungicide to the base of the plants in such way that it may soak into the ground and protect the part just below the surface.

POD ROT AND STEM ROT DUE TO RHIZOCTONIA.

Rhizoctonia attacks bean plants in three ways. (1) There is the damping off of seedlings caused by the entrance of the fungus into the succulent tissues of the young plants near the surface of the ground. (2) A dry rot of the stem brought on in older plants by *Rhizoctonia,* and somewhat destructive of them, has been described by B. M. Duggar in Bulletin 186 of the Cornell University Agricultural Experiment Station, as follows: "At a distance of from one to two inches above the surface of the soil there was a place on the stem where the tissues were dead and discolored. Frequently this occurred at the point where the plants commenced to branch. The dead part was dry-rotten clear to the pith, from one-half inch to one inch or more in length, and usually extended entirely around the stem. Being much weakened at the point of attack, it was a common thing for affected plants to be broken over by the wind. When this did not happen, the whole plant slowly dried up and died." (3) G. G. Hedgcock, in Science, n. ser. 19, p. 268, has given an account of the presence of brown sunken areas on bean pods, due to attacks of *Rhizoctonia*, the mycelium of which penetrates to, and persists in, the seed coat.

During the season of 1907 the writer had occasion to observe the last two effects. During protracted warm wet weather practically every pod in immediate contact with the ground, or with decaying material that touched the ground, showed the characteristic rotten areas. These were circular or irregular in outline, and usually a quarter of an inch to an inch or more in extent; they were slightly sunken and brown, frequently with a darker central portion, and a more or less well-marked series of concentric lines surrounding it (Fig. 14). In the earlier stages only the outer portion of the hull would be involved (Fig. 15), but later the fungus would penetrate the entire thickness and enter the seeds, causing them to rot if young, or merely discoloring them if older.

Rhizoctonia was constantly associated with these lesions; and they were readily produced by inoculations with pure cultures of this fungus on pods in all stages of development, both on the bushes and in moist chambers. Infection invariably followed the application of the fungus material when the pods were pricked or slightly injured in some other way. Pods that were similarly injured, but not exposed to *Rhizoctonia* material, did not become infected. When inoculation material was applied to apparently sound pods, infection seldom followed; but there would usually be in such cases a certain amount of bronzing of the surface in contact with the growth of *Rhizoctonia*. The attempts to infect uninjured pods were made at all stages of development, and in a number of different ways, usually by inserting the pod still attached to the bush and properly cleansed, into a test tube culture of *Rhizoctonia* growing on a steamed bean pod.

Rhizoctonia obtained from pods caused damping off of seedling beans, and infected stems of month-old plants, when uninjured as frequently, but not so promptly as when slightly injured.

Naturally induced lesions of the stems were observed in the field while the rotting of pods was common, and less abundantly at other times under drier conditions when the pods were not affected. No inoculations were made in the field for the purpose of securing the stem lesions.

At no time in the field or in cultures grown under a variety of conditions, was any spore stage of the *Rhizoctonia* seen.

Dr. B. M. Duggar very kindly examined cultures of the fungus from pods, and found them to agree with his notes on the *Rhizoctonia* causing the dry stem rot of beans in New York.

PREVENTION.

The observations of the writer, in so far as they go, indicate that damage from the rot of pods induced by *Rhizoctonia* becomes serious only when conditions of warmth and wetness are rather extreme. Such general means of prevention as care in the selection of seed, destruction of old stalks and leaves as thoroughly as may be possible, and rotation of crops, will doubtless be of benefit. The fungus is a soil organism, and probably produces spores very infrequently. Such protection as might be expected under other circumstances from spraying would not be as readily secured in this instance, both on account of the habits of the fungus, and the circumstances that invasion is rapid and at a time when weather conditions are unfavorable for adequate spraying.

LITERATURE.

Reference to the fungus causing blight of pepper, beans and other plants, is made in the following publications:

Florida Experiment Station, Bulletins Nos. 21 and 47, and Annual Report for 1896. Department of Agriculture, Division of Vegetable Physiology and Pathology, Bulletin No. 17, page 44.

The following experiment station publications contain accounts of diseases of beans:

Michigan Experiment Station, Bulletin No. 230. New Jersey Experiment Station, Bulletin No. 151. New York (Cornell) Experiment Station, Bulletin No. 239. New York (Geneva) Experiment Station, Bulletin No. 48. Ohio Experiment Station, Bulletin No. 136. Ontario Agricultural College, Bulletin No. 136.

BORDEAUX MIXTURE.

The most valuable fungicide for use in combatting plant diseases is Bordeaux Mixture, which consists of a mixture of copper sulphate (bluestone) and stone lime slaked in water.

The formula for Standard Bordeaux Mixture, sometimes known as the "6-4-50 formula," is as follows:

Copper sulphate (bluestone), pounds	6
Lime, pounds	4
Water to make, gallons	50

The bluestone should be dissolved by tying it in coarse cloth, such as gunnysack, and suspending it near the surface of 25 gallons of water placed in a wooden barrel or tub; or, more quickly, by using a small quantity of hot water and then adding cold water up to 25 gallons.

The lime should be the best quality and carefully slaked with small quantities of water until a thin, smooth paste is obtained. Water should be added to this paste until 25 gallons of milk lime is secured.

The solution of bluestone and the milk of lime should now be poured slowly together in a larger barrel, with thorough stirring to insure proper mixing.

When Bordeaux Mixture is properly prepared, it is of a brilliant sky-blue color. If the lime is air-slaked or otherwise inferior in quality, the preparation will have a greenish cast; and if this is pronounced, the mixture will injure the foliage. To test this, insert the bright blade of a pocket knife in the mixture, allowing it to remain for at least a minute. If the polished surface assumes the color of copper plate, the mixture is unsafe and more lime must be added. If the blade of the knife is unchanged, it is safe to use the mixture.

Iron or tin vessels are quickly injured by either copper sulphate or Bordeaux Mixture. Wooden, graniteware or earthenware vessels should be used.

Peach and eggplant are likely to be injured by full strength Bordeaux, and for use on such plants 60 gallons of water should be used instead of 50.

Formulas often used call for other quantities of bluestone and of lime, such as the 5-5-50 and the 5-4-50.

AMMONIACAL COPPER CARBONATE.

The formula for ammoniacal copper carbonate is as follows:

Copper carbonate, ounces	5
Strong ammonia (*Aqua ammoniae fortior*), pints	2 to 3
Water to make, gallons	50

Dilute the ammonia with about two gallons of water. Add water to the carbonate to make a thin paste, pour on about half of the diluted ammonia, and stir vigorously for several minutes; allow it to settle and pour off the solution, leaving the undissolved salt behind. Repeat this operation, using small portions of the remaining ammonia water until all the carbonate is dissolved, being careful to use no more ammonia than is necessary to complete the solution. Then add the remainder of the required amount of water—that is, up to 50 gallons—and the solution is ready for use. The solution of copper carbonate in ammonia water may be kept for some time if it is tightly stoppered. Before using it should be diluted at the rate of ten gallons of water to every ounce of carbonate in solution.

Ammoniacal copper carbonate is a clear, light-blue solution, which, upon drying, leaves little or no stain. As a fungicide it is somewhat inferior to Bordeaux mixture; but it should be used when the stain of the Bordeaux Mixture upon ornamental plants and maturing fruits is objectionable, and when the precipitate in Bordeaux prevents proper percolation through the soil.

EAU CELESTE.

Copper sulphate (bluestone), pounds	2
Strong ammonia (*Aqua ammoniae fortior*), pints	3
Water to make, gallons	50

Dissolve the bluestone in a small quantity of hot water, and add the ammonia, and then enough water to make 50 gallons.

This fungicide is likely to scald the foliage of some plants, especially eggplant.

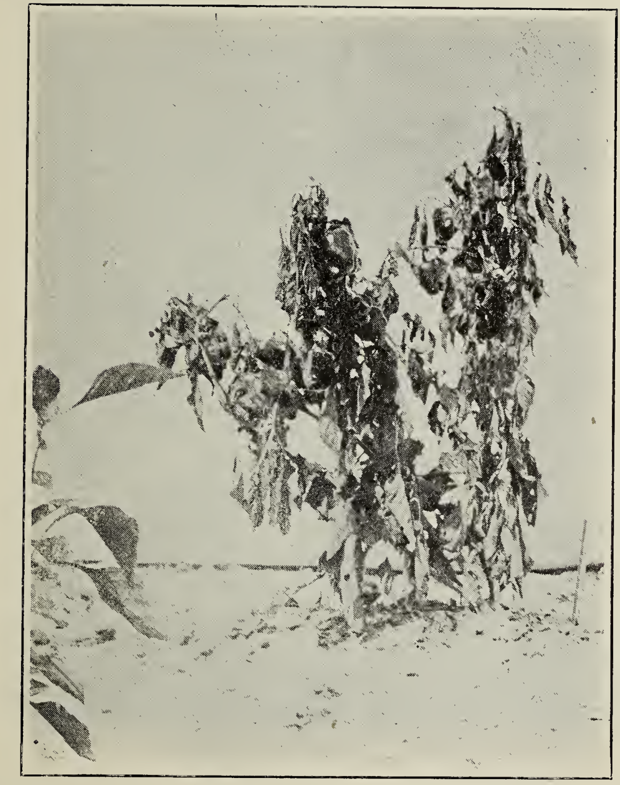

Fig. 1.—Pepper plant artificially infected with fungus blight, and showing appearance typical of affected plants.

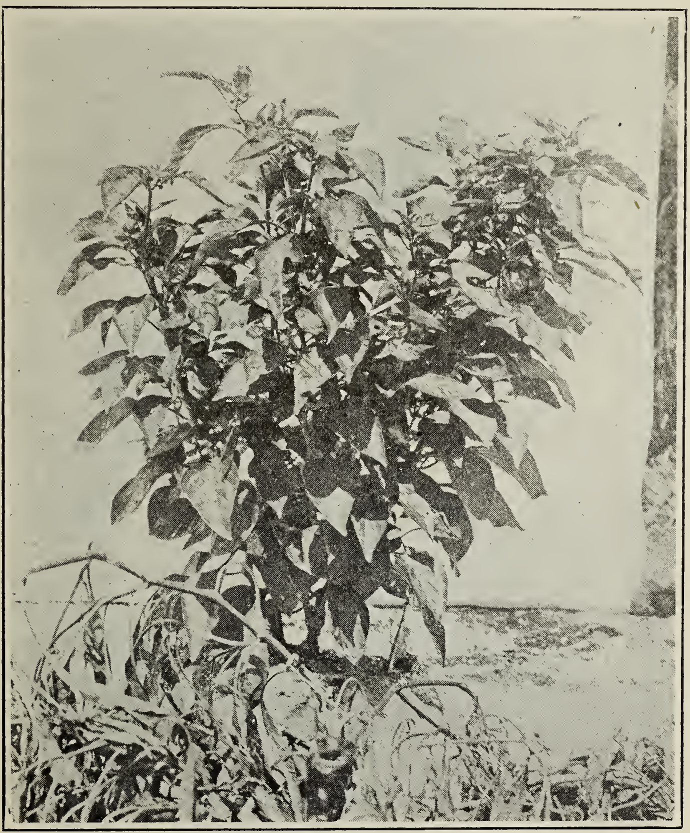

Fig. 2.—A sound, uninoculated pepper plant used as a control. In the foreground part of an inoculated plant, well wilted, is shown.

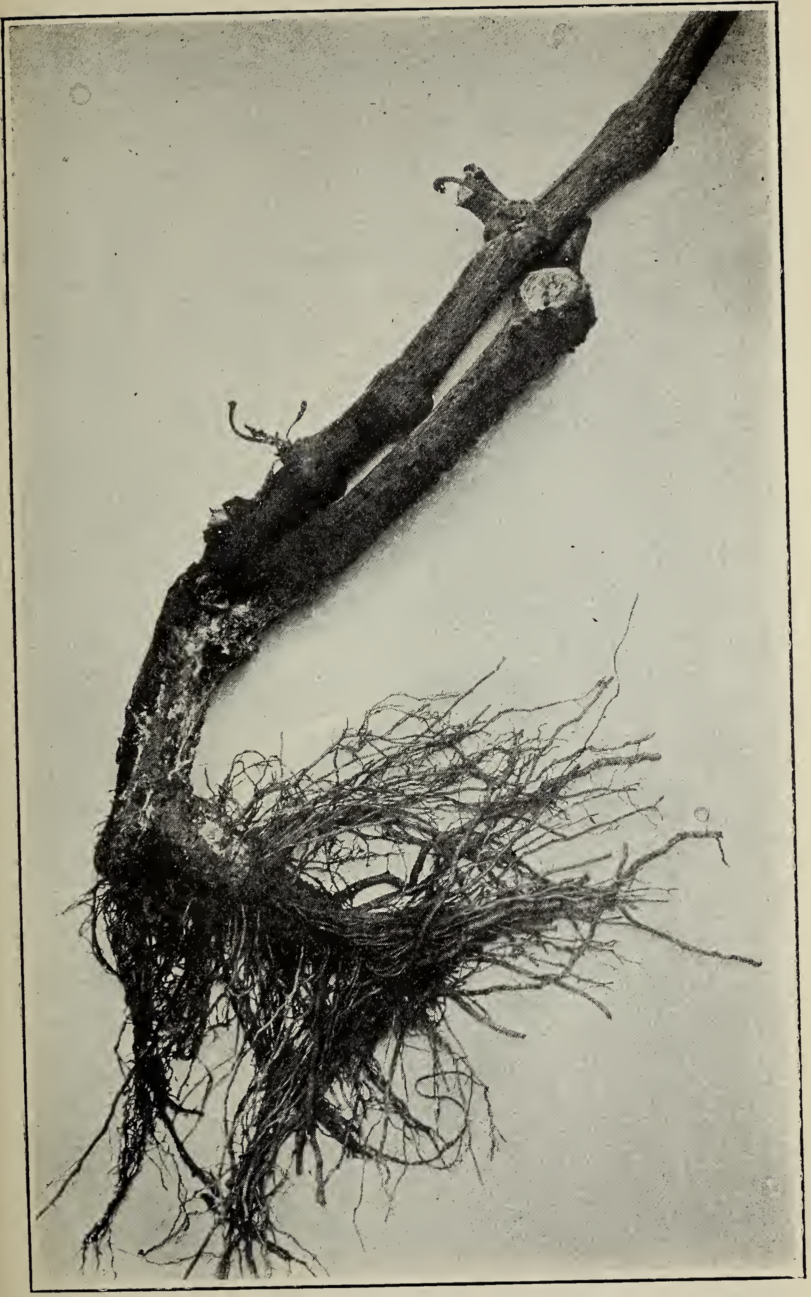

FIG. 3.—Stem of pepper plant affected just below the ground level by the blight fungus, the white mycelium of which is very conspicuous.

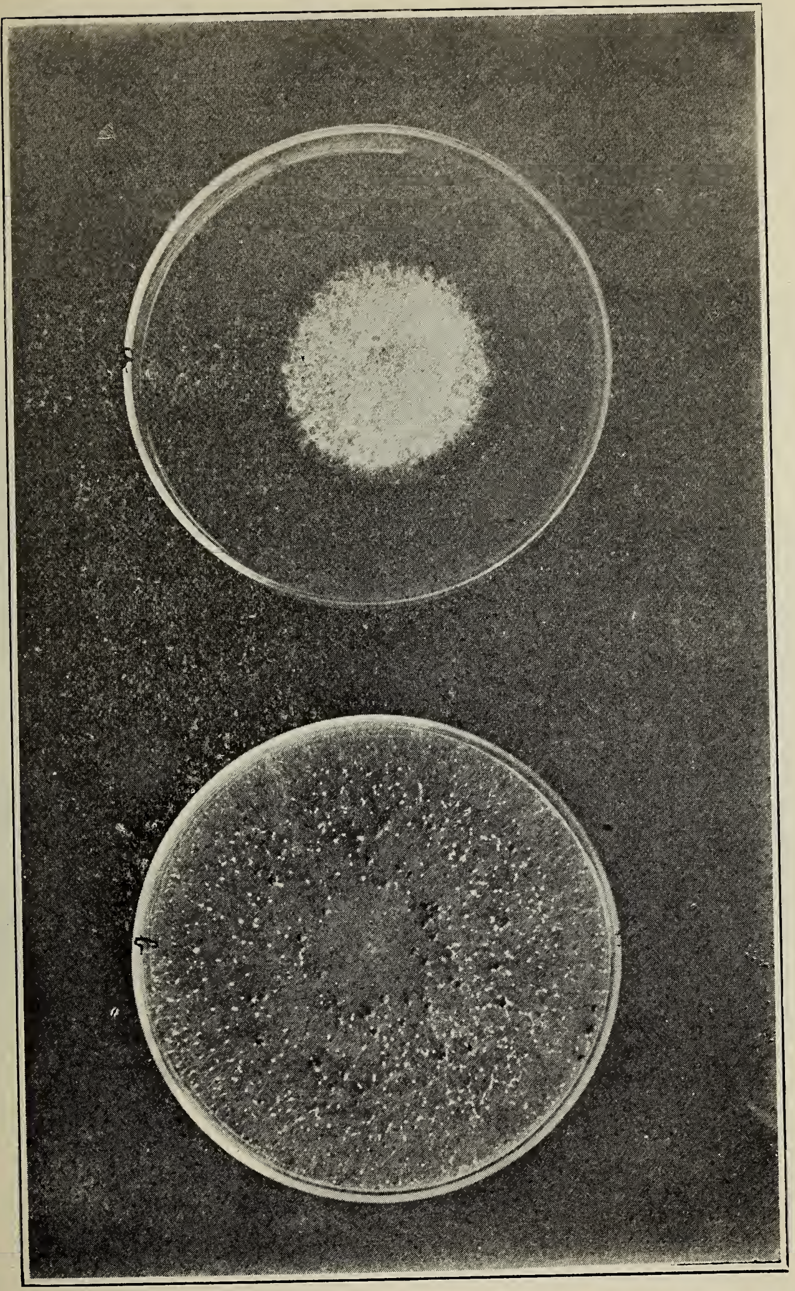

FIG. 4.—Pure cultures of the pepper blight fungus. The two are of the same age. *a* is on glycerine-beef agar, *b* is on potato agar. In *b* the fully formed brown sclerotia are evident, and the white flecks that indicate the first stages in their formation. x 5-6.

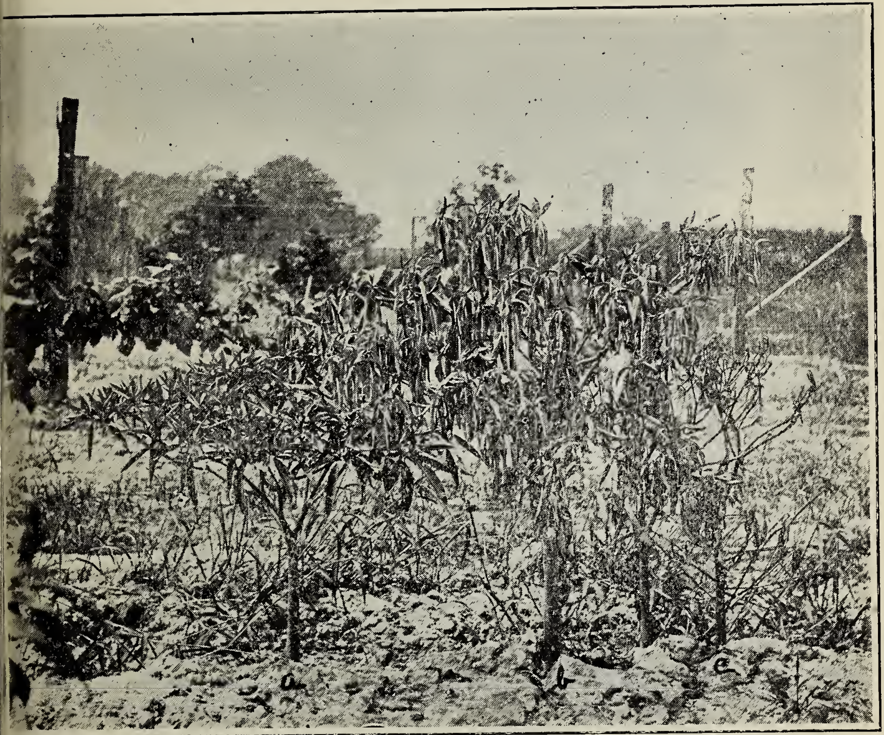

FIG. 5.—Japanese fiber plant, *mitsumata,* affected with fungus blight. *a* is sound, *b* in the first stages of wilt, *c* defoliated.

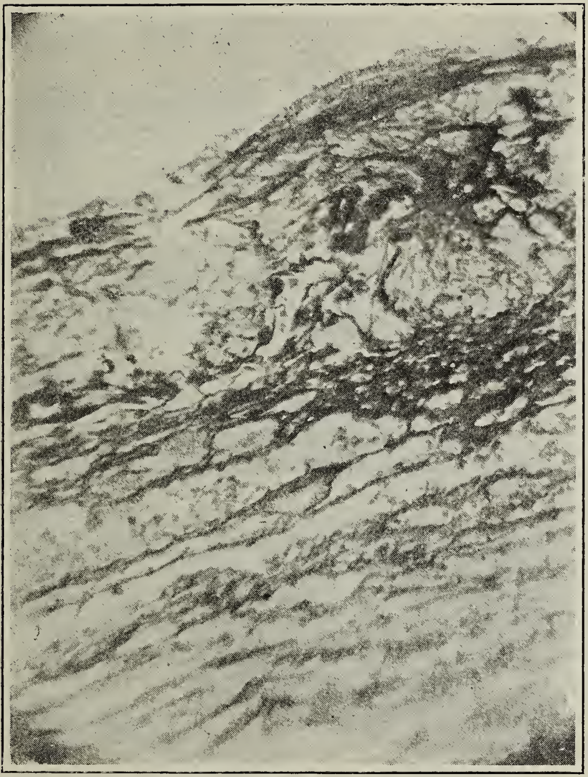

FIG. 6.—Microphotograph of bark from affected area on pepper plant. The threads of the mycelium are seen inside the disorganized cells.

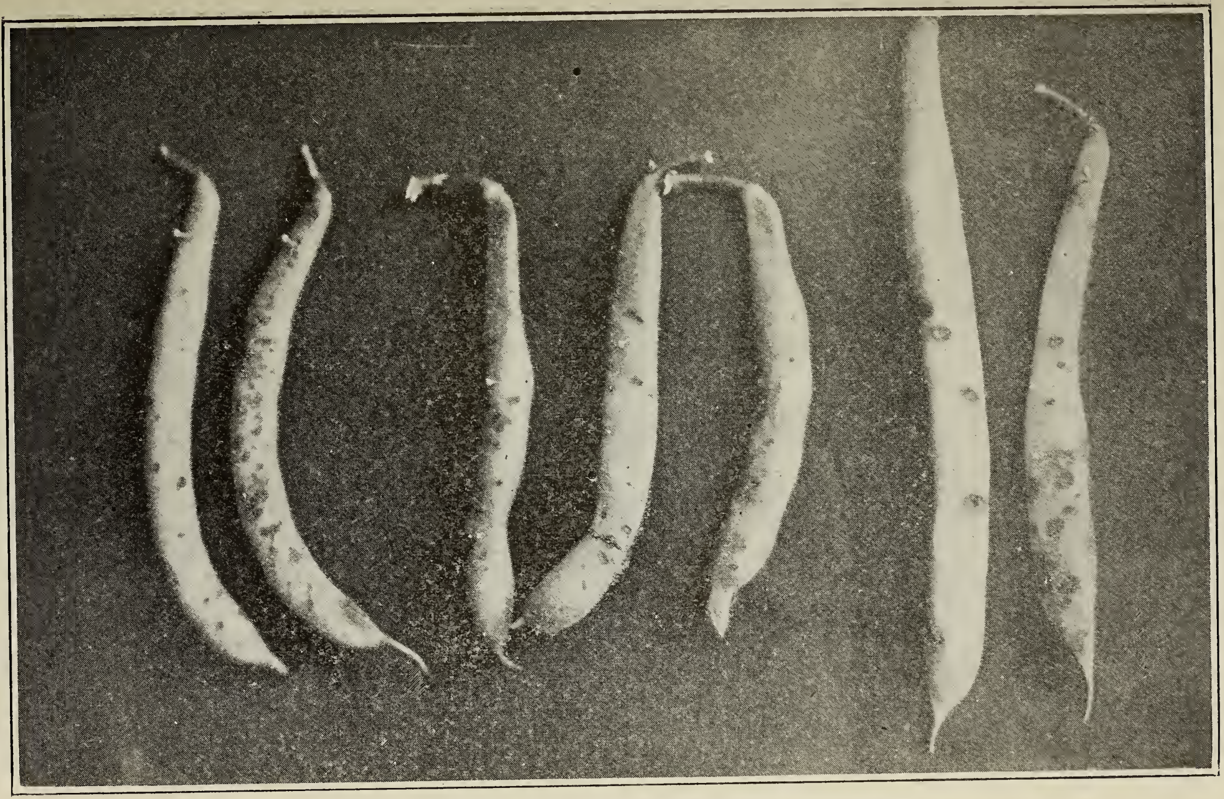

FIG. 7.—Bean pods affected with pod spot or anthracnose.

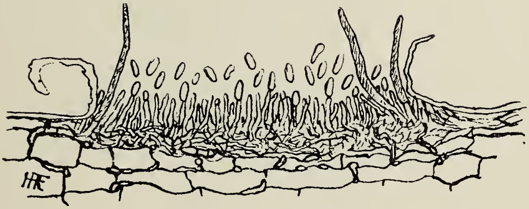

Fig. 8.—Section of a pod through anthracnose spot showing the mass of mycelium, the spore-producing branches and the spores. x 300.

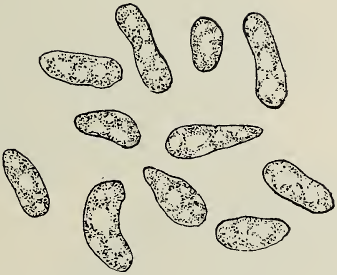

FIG. 9.—Spores of the bean anthracnose fungus. x 1000.

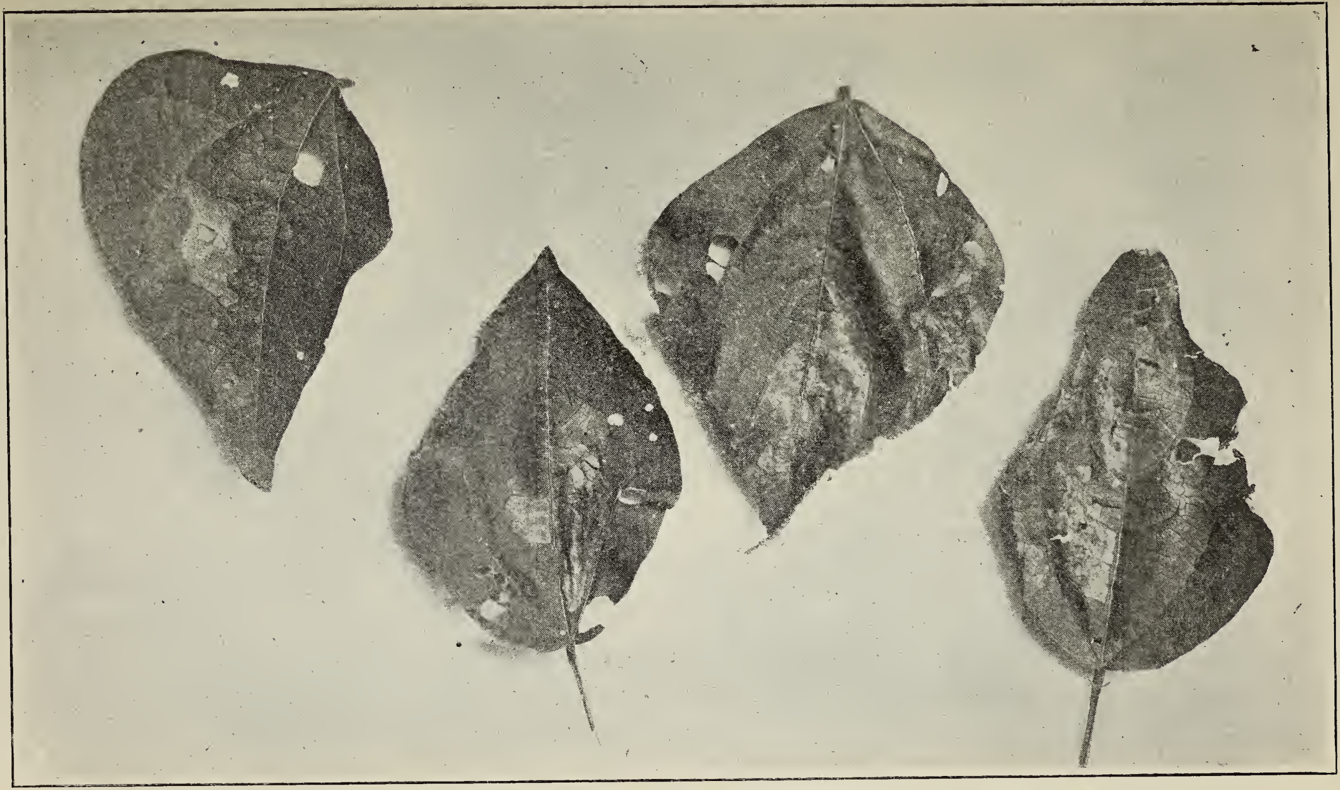

FIG. 10.—Bean leaflets showing characteristic effects of bacteriosis; rather early stages.

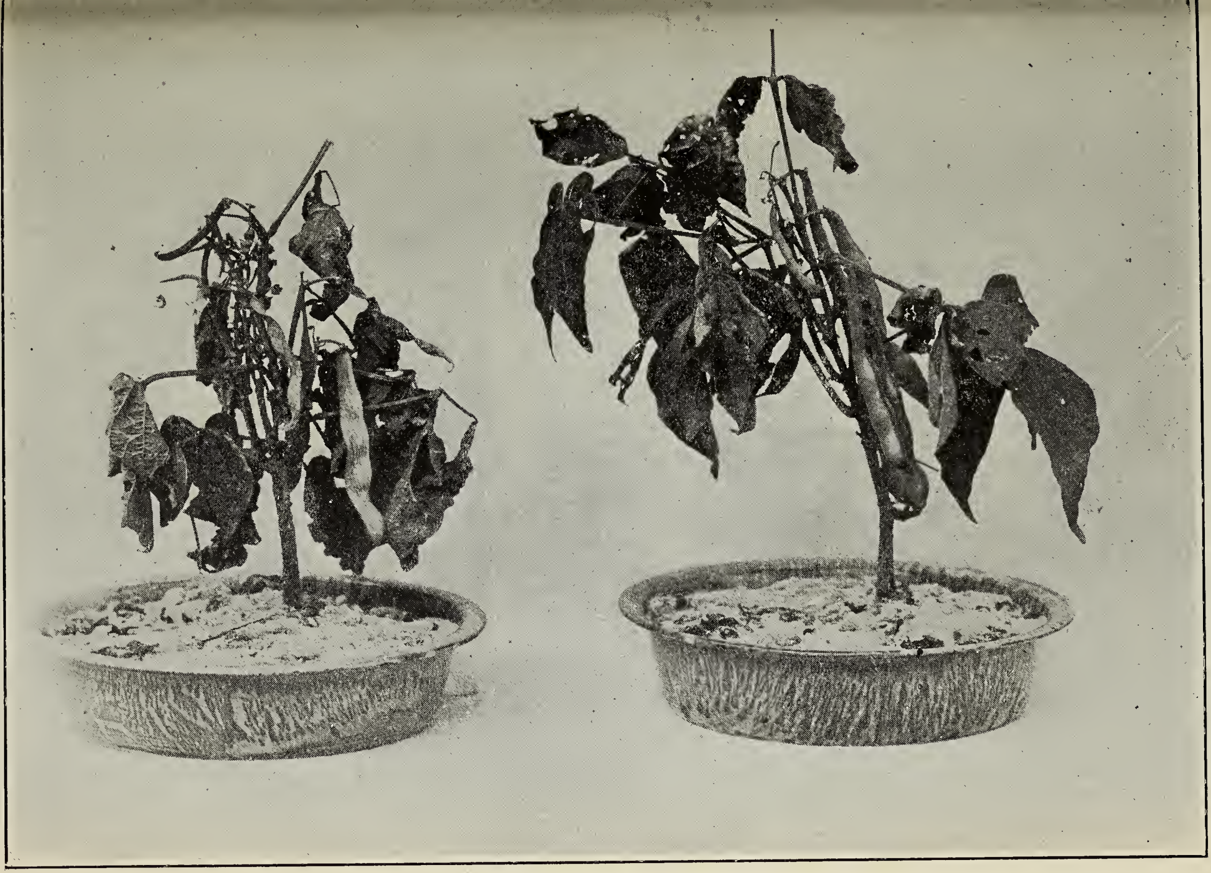

FIG. 11.—Bean plants badly affected by bacteriosis in the field. Removed to pans for the purpose of photographing.

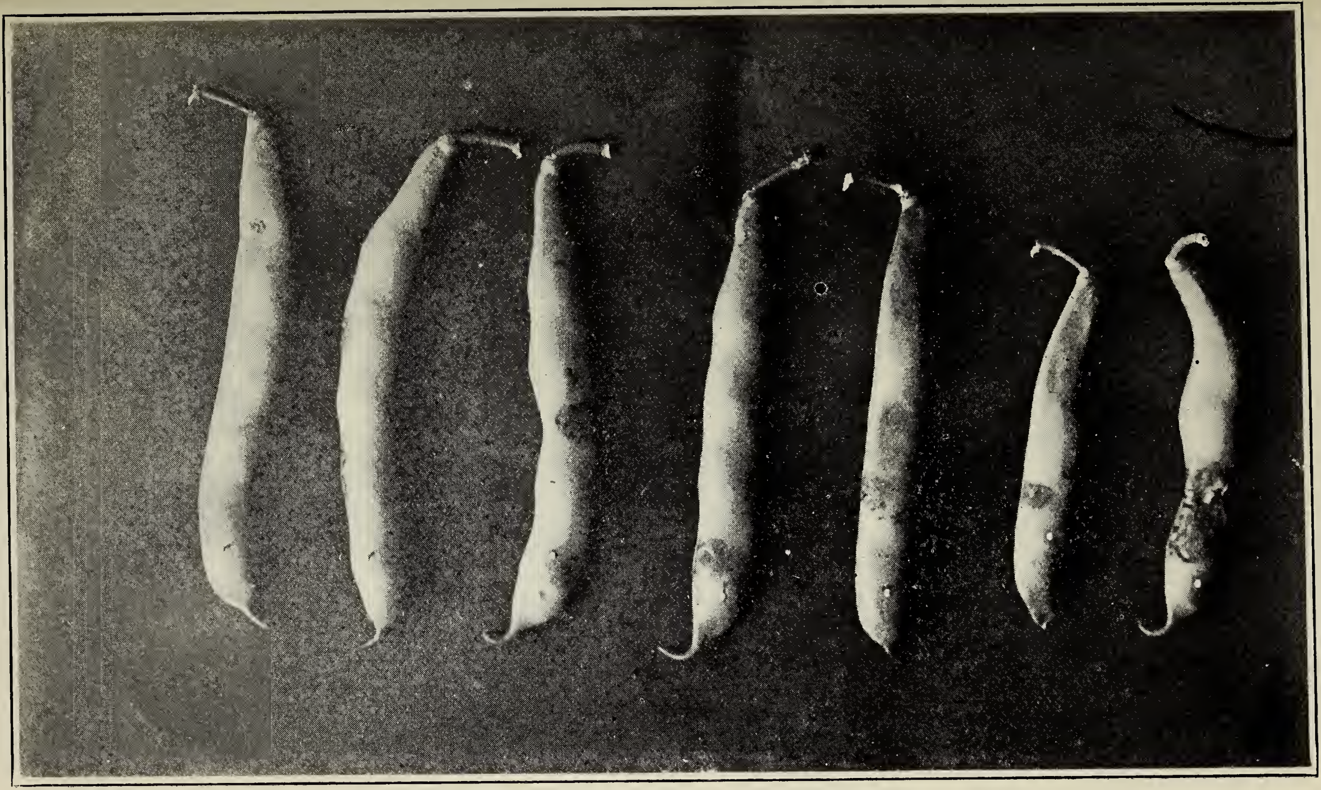

FIG. 12.—Bean pods showing typical bacteriosis lesions.

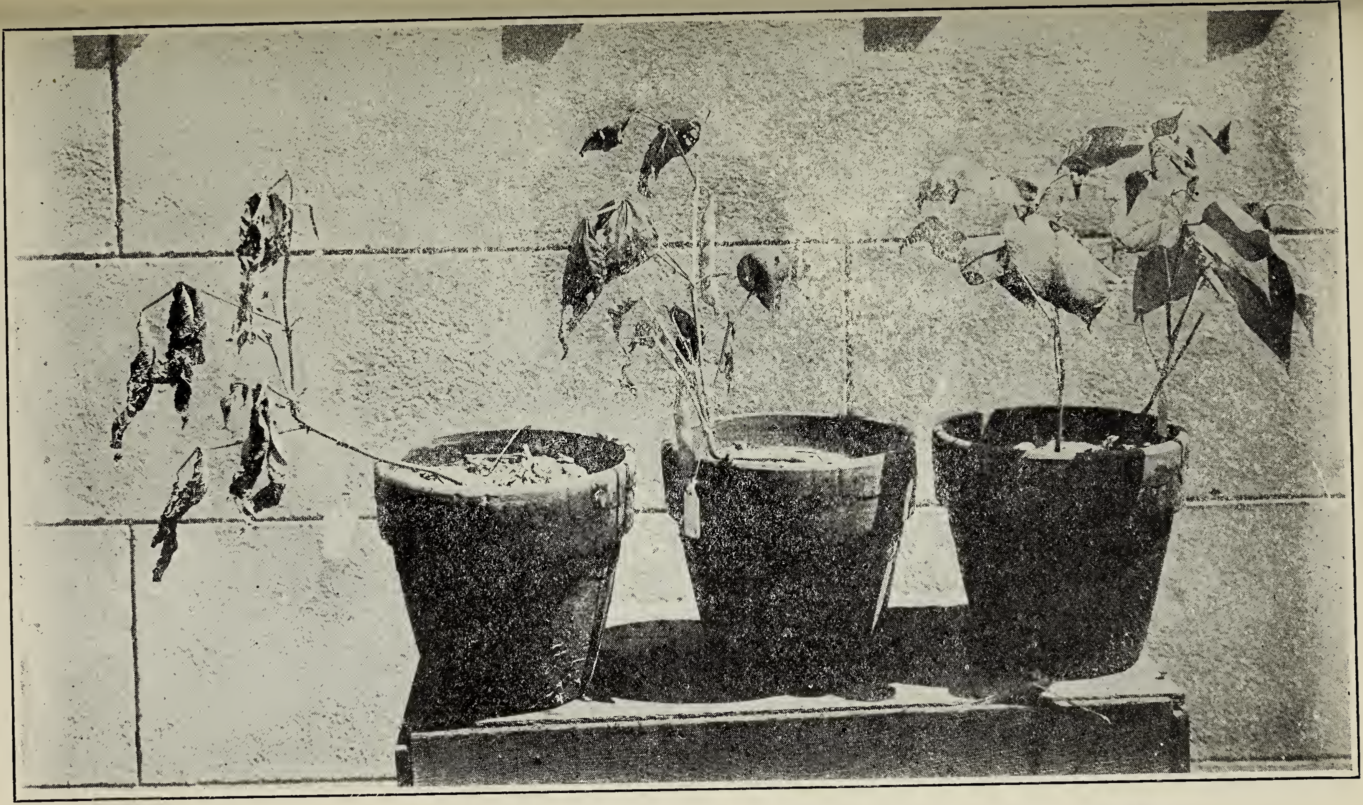

FIG. 13.—Bean plants grown in pots and artificially infected from a pure culture of the blight fungus. The bark of the plant at the left was slightly abraded before the application; the middle plant was uninjured and inoculated; the plant at the right was injured, but not inoculated.

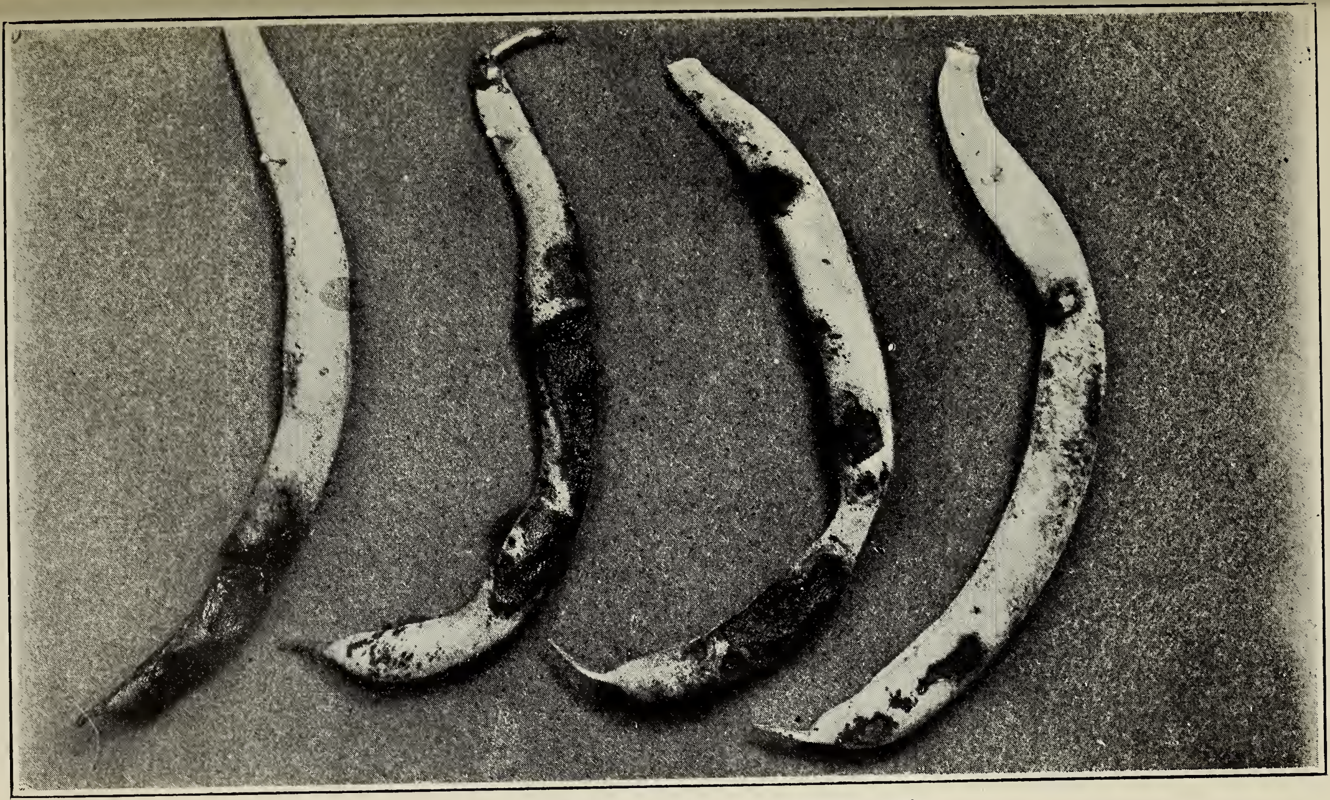

FIG. 14.—Pods affected with the rot due to *Rhizoctonia*.

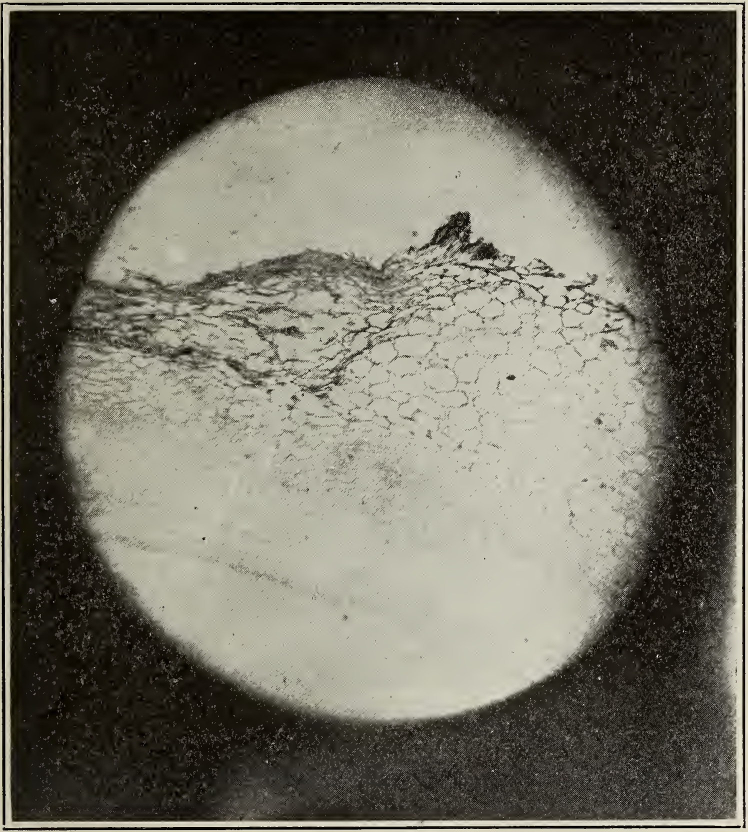

FIG. 15.—Section through rotted area on pod showing disintegration of tissue and presence of *Rhizoctonia mycelium.*

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Agricultural Experiment Station

OF THE

Louisiana State University
and A. & M. College,

BATON ROUGE.

REPORT OF

Dairy Herds and Their Milk Production

At HAMMOND, LA., and Vicinity

T. E. WOODWARD and J. G. LEE, Jr.

BATON ROUGE:
THE DAILY STATE, OFFICIAL JOURNAL OF LOUISIANA.
1908

OFFICE OF
EXPERIMENT STATIONS
BATON ROUGE, LA.

The work recorded in the following report was inaugurated after a conference between Mr. B. H. Rawl, representing the Dairy Division of the National Bureau of Animal Industry, and Dr. W. H. Dalrymple and myself, as representing the Louisiana Experiment Stations. It was the desire of the Dairy Division to undertake a series of investigations in the dairy districts of the State with the view of endeavoring to find out and, if possible, improve existing conditions by a series of milk tests and the keeping of records, etc., both of individual cows and of dairy herds, in order to be able to show to those in the dairy business, how, by intelligent methods, and proper handling and care of the cows and their product, such improvement in the industry might be brought about. It was also the wish of the Division to undertake this work in co-operation with the State Experiment Stations.

Consequently, Mr. T. E. Woodward, representing the Dairy Division, and Mr. J. G. Lee, Jr., as the representative of the Experiment Stations, were, during the past summer, placed in charge of the investigations among the dairy herds at Hammond, La., and vicinity, a work which they have carried out faithfully and well, as may be inferred from a glance at the extensive records embodied in their report, and for which I desire to express to them my appreciation.

It is to be hoped that the information given in the report may prove of value to all who may be engaged in the dairy industry throughout the State.

W. R. DODSON,
Director.

REPORT

OF

Dairy Herds and Their Milk Production

AT HAMMOND, LA., AND VICINITY

By T. E. Woodward and J. G. Lee, Jr.

The cattle kept around Hammond are practically all of mixed breeding and in most cases show a preponderance of Jersey blood, but there are a few herds in which the Holstein blood predominates. The cows are not as heavy producers as those in some other sections of the state for two reasons, because little attention has been paid to their breeding and because they are not supplied with sufficient green feed. Most of the cows run on the open range, which makes it difficult for the owner to keep a record and control their breeding; raising of calves on whole milk is expensive; the necessity of breeding up is not so great as in sections of the state where butter is made, because of the much higher price received for the milk at Hammond In other words, a man can make a living off a poorer bunch of cows where whole milk is sold than he can where it is necessary to depend upon the sale of butter alone. These are the reasons for the inattention to breeding in this vicinity and accounts for the comparatively small number of pure-bred bulls kept.

Nearly all of the cows during the day run on the open range, where they have access to carpet grass, piney woods grasses, and later in the season lespedeza, also. At night they are kept in a dry lot. The carpet grass comes on early in the spring and would undoubtedly make a good pasture grass in the late spring and early summer were it not for the fact that it grows so close to the ground that cows have difficulty in getting enough of it to satisfy their appetites. Later in the season this grass becomes tough and woody. Piney woods grasses are said to be of scarcely any value except for a couple of months in the spring. Lespedeza is rather late in starting in the spring, but makes a good growth and good pasture on rich soil. But unfortunately for the lespedeza the soil around Hammond is naturally poor so that this plant does not as yet add much to the value of the pasture. The small number of cows which do not run on the open range have practically the same sort of pasture—carpet grass, piney woods grasses and lespedeza. Some of the farmers have small fields of crab grass in summer and oats in winter on which they pasture their cows part of the time. Both of these furnish excellent pasturage. If the farmers would devote more attention to the growing of pasture and forage crops and to the production of silage so that an abundance of green feed could be supplied the year round they would find that their cows would be healthier, would yield more milk, and at much less outlay for grain feed. There are several reasons why the farmers do not raise more of their own feed; only a small portion of the land is cleared; clearing is very expensive; the land has a high value for trucking purposes, and the making of a crop is uncertain because of imperfect drainage of the land.

The sanitary conditions of the stables and yards, on the whole, are very good, and the milk is all cooled immediately after being drawn. The greatest objection to the stables is that they have been built without making any provision for ventilation. Some of them have no windows at all and in many cases the cows face close up against a tight board wall, where they are forced to breathe and rebreathe the same air over and over again.

The object of making tests of the milk from herds around Hammond was primarily to ascertain the percentage of butter fat and also per cent of solids not fat in the milk and to find out, how near it came to the New Orleans standard, which requires 9.5 per cent of solids not fat and 13 per cent of total solids.

The samples were taken at the barns either by the representative of the Louisiana Experiment Station or by the representative of the Dairy Division, Bureau of Animal Industry, United States Department of Agriculture, both of whom are stationed at Hammond, and to their knowledge correctly represent the milk of the various herds.

The fat in these samples was determined by the Babcock test with tested glassware, and the specific gravity by a Westphal balance. The solids not fat were then estimated from this data by means of a table in Farrington & Well's book on testing. Duplicate tests were made on each sample of milk.

The following is a detailed report of each herd in the vicinity of Hammond. These tests were all made in the spring and summer at the time of year when there are more fresh cows and better pasture than at any other season, consequently the yield of milk is greater and the percentage of both fat and solids not fat is less than at any other time of the year:

HERD NO. 1.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
1907.				
May 8 p. m....	1.0309	4.9	8.71	38 Gals.
May 9 a. m....	1.0312	4.7	8.73	40 Gals.

This herd consists of forty cows, eight of which are grade Holsteins and thirty-two are grade Jerseys—a cross with the common old scrub cow.

The owner of this herd has been in the dairy business for several years, and by culling out the poor cows and raising calves from his best cows has gotten together a good herd, as will be seen from the amount of milk yielded—seventy-eight gallons per day from forty cows—which is a very good record for a herd of this size when kept under the conditions which exist in the vicinity of Hammond.

Each cow receives an average of six pounds of corn meal, six pounds of cotton seed meal, and six pounds of hulls per day.

The majority of this herd is bred to freshen in fall and winter.

HERD NO. 2.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
May 1 p. m....	1.0343	3.8	9.35	10 Gals.
May 2 a. m.....	1.0346	3.9	9.45	9 Gals.

This herd consists of eleven cows, in ten of which the Jersey blood predominates and in one the Holstein blood predominates.

The milk from this herd tested lower in fat than that of any other herd. The reason for this is accounted for by the cows being in full flow of milk and had been fresh only a short time when the test was made.

This herd is well handled, the only objection, of any consequence, being that the feed is changed too often for best results. At the time this test was made, each cow was receiving three pounds of cotton seed meal, six pounds of corn meal and six pounds of hulls per day.

The most of these cows are bred to freshen in the spring.

HERD NO. 3.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
May 3 p. m....	1.0340	4.5	9.42	5 Gals.
May 4 a. m....	1.0345	5.3	9.70	5 Gals.

This herd consists of eleven cows, in all of which the Jersey blood predominates over the scrub, or common cow.

The low production and high test of this herd is explained by the fact that the cows have been milking for a long time, and also that it has been troubled considerably with abortion.

The herd is handled very well, the owner being very kind and thoughtful of the cows, as is the case with most of the dairymen in this vicinity.

Each cow receives seven pounds of a mixture of corn meal and cotton seed meal per day; one part of cotton seed meal to two parts of corn meal being used to make this mixture.

Most of these cows are bred to freshen in the summer and fall.

HERD NO. 4.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
Aug. 6 p. m. . .	1.0312	4.4	8.69	55 Gals.
Aug. 7 a. m. . . .	1.0316	4.1	8.73	53 Gals.

This herd is one of the few in which the Holstein blood predominates, there being forty-nine head, which show evidence of Holstein blood, and twenty-one which show presence of Jersey blood, consequently, as might be expected, the percentage both of fad and solids not fat, is lower than the average for this vicinity.

There are many excellent cows in this herd and by breeding them to a good bull and raising the heifer calves, an excellent herd of cows could be raised; but, unfortunately, the owner doesn't take much interest in this phase of the work. Most of these cows are bred to freshen in the spring.

The feed consists of equal parts of corn meal, bran and cotton seed meal, ten pounds being fed per head per day.

HERD NO. 5.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
Aug. 14 p. m. .	1.0314	4.2	8.70	10 Gals.
Aug. 16 a. m. .	1.0323	4.2	8.93	10 Gals.

Like the preceding herd, the Holstein blood in this herd predominates, there being eleven grade Holsteins and two common cows.

Of all the dairymen around Hammond, this one is making more progress than any of the others in improving his herd. He breeds his cows to a good bull and raises the heifer calves. The cows are excellently handled and fed. His greatest handicap is, in not having any cleared land on which to grow pasture and forage crops.

Most of these cows are bred to freshen in the fall so as to meet the advanced price of milk in the fall and winter.

The feed consists of four pounds cotton seed meal and four pounds shorts per head per day.

HERD NO. 6.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
May 8 p. m....	1.0334	4.8	9.33	4 1-2 Gals.
July 25 a. m..	1.0320	5.5	9.12	4 Gals.

There are six cows of mixed breeding in this herd and in all of them the Jersey blood predominates; they have been milking for some time, which accounts for the high test in both fat and solids not fat.

These cows are handled fairly well. The owner does his own milking, is very kind and feeds quite enough for the amount of milk he receives. Cows are bred to freshen in the winter and late fall.

Each cow receives eight pounds corn meal and four pounds cotton seed meal daily.

HERD NO. 7.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
July 22 p. m..	1.0322	4.4	8.95	11 Gals.
July 23 a. m..	1.0320	4.2	8.85	13 Gals.

The outlook for this dairy is very promising; the herd consists of seven grade Jerseys and ten grade Holsteins. While the farm is much too small for the number of cows kept, all the land is cultivated to its fullest extent in forage crops which are fed green to the cows. There are some animals in this herd that are not paying a very large profit, as the production would indicate, but they will be gotten rid of as soon as heifers can be raised to take their places.

Taking everything into consideration, this herd is well handled—being well fed and cared for in general. The feed consists of a mixture of equal parts corn, bran and cotton seed meal, one pound of mixture being fed to every two pounds of milk produced. Cows are bred to freshen in fall and winter.

HERD NO. 8.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
July 22 p. m..	1.0326	4.6	9.09	16 Gals.
July 23 a. m..	1.0323	4.6	9.01	16 Gals.

This is rather a common bunch of cows of mixed breeding, all of which are very common judging from general external appearances. The fact that they are very commonly handled partly accounts for the low production.

The cows receive three pounds of cotton seed meal, three pounds bran, and three pounds corn meal per cow daily.

HERD NO. 9.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
April 30 p. m..	1.0320	3.8	8.77	9 Gals.
May 1 a. m....	1.0327	4.1	9.00	9 Gals.

This herd consists of eleven cows, three of which are good grade Holsteins and seven are good grade Jerseys, while the other cow is a pure-bred Jersey.

The butter-fat test of this herd is low because most of the cows have been fresh but a short time.

This dairyman is on the right track; he has a good Holstein bull, raises the heifer calves from his best cows; and keeps a record of his herd so that he knows exactly how much money each cow is making or losing for him.

This man does all of his dairy work and in addition, finds time to grow considerable feed for his cows. Most of these cows freshen in the spring.

Each cow receives three pounds of corn meal, three pounds shorts, and one and one-half pounds of cotton seed meal per cow daily.

HERD NO. 10.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
Aug. 13 p. m..	1.0322	4.8	9.03	43 Gals.
Aug. 17 a. m..	1.0324	4.4	9.00	47 Gals.

This dairyman will never make much progress or money either, until he changes his methods. He has a herd of 69 cows, fourteen of which show presence of Holstein blood and fifty-five give evidence of Jersey blood, and all of them are very poor specimens of dairy cows, as can be seen by glancing over the production. There isn't any attention paid to selecting heifer calves from the best cows, thereby improving the herd, but a cow is simply a cow and one cow does this man as much good as another.

This dairyman pays no attention to growing feed stuff for his cows, but depends entirely upon the commercial feeding stuffs.

This man, however, is fortunate in having three or four children to help do the milking, or else his expenses would be much greater than his income.

There isn't any particular time for the cows to freshen, as they are coming fresh all during the year.

Each cow receives eight pounds of a mixture of equal parts corn meal, cotton seed meal and bran, daily.

HERD NO. 11.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
July 31 p. m..	1.0296	4.8	8.37	13 Gals.
Aug. 1 a. m...	1.0313	3.8	8.59	15 Gals.

This herd consists of eighteen cows, two of which show Jersey blood and sixteen of which show Holstein blood, and are very good producers as compared with the other herds around Hammond.

The wide variation in the percentage of butter fat between morning and evening milkings is due to the fact that the cows are milked very early in the afternoon, which makes the evening milk test much higher.

Very little intelligence is exercised in the management of this herd; the sanitary conditions are not as good as could be expected and the management of the feeding is very poor.

Most of the cows freshen in the fall.

Each cow receives four pounds of cotton seed meal daily.

HERD NO. 12.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
Aug. 13 p. m..	1.0306	4.4	8.54	20 Gals.
Aug. 14 a. m..	1.0309	4.4	8.61	19 Gals.

This dairyman has a herd of very good producers, as will be seen by looking over the production; this can partly be accounted for by the fact that there are fifteen good cows in which the Holstein blood predominates and only ten in which the Jersey blood predominates, and, too, all of these cows, or most of them, were raised on the farm.

The sanitary conditions of this dairy are very bad, and as a whole, the writer can't say that the management is good.

Most of the cows freshen in the spring.

Each cow receives about nine pounds of a mixture of two parts corn meal and one each of shorts and bran.

HERD NO. 13.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
July 19 p. m..	1.0322	3.6	8.78	7 1-2 Gals.
July 20 a. m..	1.0318	4.3	8.83	7 1-2 Gals.

This herd consists of twelve cows, two of which have Jersey blood and unknown blood mixed, two show Holstein blood mixed with some unknown blood, two show Shorthorn blood and some unknown blood, and the remaining six are scrubs, or breeding unknown.

The sanitary conditions of this dairy are very good; the milk is handled in an excellent way.

This dairyman is a believer in feeding pea-vine hay for roughage and has received excellent results from feeding it. Each cow receives eight pounds of a mixture of equal parts of corn meal and cotton seed meal and fifteen pounds pea-vine hay per cow daily. The owner thinks pea-vine hay is far superior to hulls as a roughage. Cows are mostly bred to freshen in the fall and winter.

HERD NO. 14.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
April 27 p. m..	1.0319	4.7	8.93	24 Gals.
April 28 a. m..	1.0323	4.8	9.05	26 Gals.

The owner of this herd is probably making more money than any other in the vicinity of Hammond. He is milking thirty-one cows, in five of which Holstein blood predominates, and in twenty-six, Jersey blood predominates. He and his wife do all of their work and not a cent is paid out for labor of any kind.

The value of a good pasture is fully appreciated on this farm and the owner makes an attempt to grow as much oats and crab-grass as possible.

Little attempt has been made to the breeding up of the herd, mainly because there has been no trouble, heretofore, in buying good heifers cheaper than they could be raised.

Most of these cows are bred to freshen in the late fall and winter.

At the time of this test, the pasture was fairly good and the cows only received two and one-half pounds of shorts, two and one-fourth pounds of cotton seed meal, and two pounds of hulls per head per day.

HERD NO. 15.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
July 26 p. m..	1.0322	4.0	8.86	4 Gals.
July 27 a. m..	1.0320	5.0	9.02	4 Gals.

This is a herd of very poor cows; consists of nine cows, all of which are scrubs, or piney woods cows as they are called, here. These cows are very poorly handled and fed under very bad sanitary conditions.

Most of these cows are bred to freshen in the spring.

Feed consists of two equal parts of caddo meal, cotton seed meal and corn meal per cow per day.

HERD No. 16.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
May 6 p. m....	1.0323	3.8	8.84	15 Gals.
May 7 a. m....	1.0323	4.6	9.01	16 1-2 Gals.

This herd consists mainly of heifers which have been raised by the owner; three are of mixed breeding with Holstein blood, and fifteen are of mixed breeding, with Jersey blood in evidence.

While this herd is fairly well cared for, insufficient attention is given to the way the cows are fed. They are given the same amount of feed whether the yield is one or three gallons of milk per day per cow. Most of these cows freshen in the spring.

Each cow receives four pounds cotton seed meal, and four pounds corn meal per day.

HERD No. 17.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
May 7 p. m....	1.0311	4.9	8.77	33 Gals.
July 24 a. m..	1.0310	4.4	8.64	47 Gals.

This herd consists of fifty-seven cows, fourteen of which are of a mixture of Holstein and some other foreign blood, and forty-three show evidence of Jersey blood mixed with some unknown blood.

The cows of this herd are well cared for and are fed in proportion to the amount of milk yielded.

The fact that the milk tested lower in the morning than in the afternoon is accounted for by the cows being milked very early in the afternoon and, also, the difference in production is accounted for for the same reason.

Most of these cows come fresh in the winter and spring.

Each cow receives feed in proportion to the amount of milk she produces, about one pound of a mixture of equal parts of cotton seed meal, corn meal and bran being fed to every two pounds of milk produced.

HERD NO. 18.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
May 2 p. m...	1.0334	3.9	9.14	25 Gals.
May 3 a. m...	1.0330	4.6	9.19	25 Gals.

This herd consists of thirty-one cows, two of which show evidence of Holstein blood, while the remaining twenty-nine show evidence of Jersey blood.

The production in this case would indicate that this is a herd of good cows, while, as a matter of fact, it is not above the average in this respect. The high production is due to the fact that the cows have been fresh only a short time, as most of them are bred to freshen in the spring.

Each cow receives three pounds of cotton seed meal and three pounds of corn meal per day.

HERD NO. 19.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
July 25 p. m..	1.0319	4.2	8.82	24 Gals.
July 26 a. m..	1.0314	5.1	8.89	27 Gals.

Three cows of this herd show evidence of Holstein blood and twenty-seven show evidence of Jersey blood, but practically nothing is known of the correct breeding.

About one-half of the herd is bred to freshen in the spring, while the other half is bred to freshen in the fall.

Each cow receives four pounds of corn meal and four pounds of cotton seed meal per day.

HERD NO. 20.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
May 3 p. m.....	1.0331	5.1	9.31	11 Gals.
May 4 a. m.....	1.0338	4.6	9.39	11 Gals.

This dairyman takes a great pride in producing rich milk; therefore, his herd consists of mostly high grade Jerseys—fifteen in all; and are bred to freshen in spring.

The writer can not help but mention the fact that this barn and general surroundings appear to be very clean, and particular pains are taken with the milk to keep it clean as possible.

Each cow receives eleven pounds of a mixture of two parts cotton seed meal and one part corn meal. This is more grain than the milk yield justifies and especially more cotton seed meal than it is deemed advisable to feed any cow.

HERD NO. 21.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
May 14 p. m..	1.0331	4.9	9.27	13½ Gals.
May 15 a. m..	1.0329	5.2	9.28	14½ Gals.

The owner of this herd has been in the dairy business for a long time and has probably done more than any other man towards improving the cattle of this section by the introduction of good bulls. His herd consists of eighteen cows, one Ayrshire, four Holsteins and thirteen Jerseys, all of which are mixed with unknown blood.

These cows at present are not producing as well as they might on account of the best cows having been sold and the poor quality of labor which the owner has to contend with.

The cows are, also, overfed; each receiving fourteen pounds of grain, of which two parts are corn meal, one part cotton seed meal, and one part nutriline.

Most of the cows are bred to freshen in the spring.

HERD NO. 22.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
Aug. 14 p. m..	1.0325	4.8	9.10	2 Gals.
Aug. 15 a. m..	1.0324	4.6	9.04	1½ Gals.

This dairyman only milks three cows, all of which have Jersey blood in prominence, mixed with some unknown blood. These cows all come fresh in early spring, which accounts for the low production.

These cows are poorly handled being kept in a poorly-made shed in which the sanitary conditions are very poor.

Each cow receives about three pounds of cotton seed meal with a little hay or collard tops per day.

HERD NO. 23.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
May 22 p. m....	1.0304	4.2	8.45	10 Gals.
May 23 a. m....	1.0304	4.7	8.55	10 Gals.

This herd consists of fifteen cows, five of which are Jersey and ten are Holstein, with a mixture of some foreign blood. There isn't any special time for these cows to come fresh, as they are bred at random and no attention is given to the time of year that it would be most profitable to have fresh cows, as is the case with the majority of dairymen.

The sanitary conditions of this dairy are not very good. Not enough ventilation and light being present for the good health of the cows.

Each cow receives three and one-half pounds of cold pressed cake per day and in the writer's opinion, this isn't enough grain to secure the best results in milk production.

HERD NO. 24.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
May 6 a. m....	1.0328	4.4	9.10	11 Gals.
July 23 p. m....	1.0303	4.2	8.42	11 Gals.

The owner of this herd is probably the poorest handler of cows in this section of the country. The cows are treated very roughly; kept in a very unsanitary barn and milked under very bad conditions. The herd consists of three Holstein and nine Jersey cows, all of which are not of pure breeding, but mixed with unknown blood.

A glance at the production would indicate that this herd is a herd of fine producers, but the fact is that these cows nearly all freshen in the late spring, hence the good showing made in production at this time.

Each cow receives four pounds of cotton seed meal and eight pounds of shorts per day.

HERD No. 25.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
May 2 p. m.	1.0312	4.4	8.69	40 Gals.
May 3 a. m.	1.0327	4.1	9.00	40 Gals.

The owner of this herd is probably better posted on the dairy business than any other man in this section. He owns a herd of forty-seven cows, four of which are Holstein and forty-three are Jerseys, all of which are more or less mixed with some unknown blood. His cows are intelligently handled and fed; he keeps a good bull and raises the heifer calves from his best cows.

A complete record is kept of the herd, and in this way the owner knows exactly what each cow is doing. The herd has been culled out until practically every individual pays a profit. This dairyman, unlike many others, does not hesitate in getting rid of the "boarders."

Feed for each cow consists of seven pounds equal parts corn meal, cotton seed meal and bran.

Cows are mostly bred to freshen in spring.

HERD No. 26.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
July 24 p. m. .	1.0324	4.2	8.95	18 Gals.
July 25 p. m. .	1.0322	4.6	8.99	19½ Gals.

This is another herd in which abortion has done considerable damage; it consists of twenty-seven cows, in which Jersey blood and common blood is mixed, and possibly a trace of other blood.

This dairyman, with the assistance of his family, does all of his work, so is able to make some money in spite of the fact that he has a herd of poor cows.

Most all of these cows freshen in the fall and spring.

Feed consists of three pounds of corn meal and three pounds of cotton seed meal per head per day.

HERD NO. 27.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
May 6 a. m. . .	1.0320	3.9	8.79	43 Gals.
July 31 p. m. . .	1.0315	4.4	8.77	38 Gals.

This herd consists of fifty-five cows, eight of which are Holstein with a mixture of unknown blood, and forty-seven are Jerseys with a mixture of unknown blood.

This dairyman raises some calves, but keeps a scrub bull, so it is doubtful whether raising calves under these conditions pays.

Neither he nor his help handle the cows as gently as they should.

Each cow receives three pounds cotton seed meal, one pound of corn meal and eight pounds of hulls per day.

Most of the cows come fresh in the spring.

HERD NO. 28.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
Aug. 14 p. m. . .	1.0322	4.9	9.05	15 Gals.
Aug. 15 a. m. . .	1.0325	4.7	9.08	19 Gals.

This herd of cows consists of 21 Jerseys mixed with traces of unknown blood. Taking this herd as a whole, they are about on an equal with the majority of herds around Hammond.

The sanitary conditions of this dairy are not at all good, and the same is true of the barn yard and general surroundings.

The animals are not handled as gently as they might be, the milkers being entirely too rough with them at times.

There is being no effort made at all towards improving the herd, as the cows are allowed to take up with any kind of a scrub bull that happens to come along.

Each cow receives five pounds cotton seed meal, five pounds corn meal and eight pounds of hulls per day.

HERD NO. 29.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
July 30 p. m. . .	1.0319	4.6	8.91	21 Gals
July 31 a. m. . .	1.0309	4.9	8.71	22 Gals.

The owner of this herd is one of Hammond's pioneer dairymen. He has a good bunch of cows, as will be seen from the amount of milk produced; they consist of five Holsteins intermixed with other blood, and sixteen Jerseys mixed with other blood.

The greatest fault that can be found with this dairy is that the barn has been built without taking into consideration the matter of ventilation, light or sanitation.

The greater portion of these cows are bred to freshen in the winter.

Each cow receives on an average of five pounds corn meal, one and one-half pounds cotton seed meal and two and one-half pounds bran and two and one-half pounds of hulls per day.

HERD NO. 30.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids. Not Fat.*	*Production.*
May 1 p. m.	1.0325	4.4	9.02	19 Gals.
May 2 a. m.	1.0340	4.7	9.46	21 Gals.

This is another pioneer dairyman who has a fairly good bunch of cows, consisting of three that have Holstein blood in prominence with other unknown blood, and sixteen that have Jersey blood in prominence with other blood.

The greatest mistake of this dairyman at present is in using a bull of the beef type for the purpose of getting heifers to raise for dairy purposes. Most of the cows freshen in the spring.

Each cow receives eight pounds of a mixture of two parts corn meal and one part cotton seed meal per day.

HERD NO. 31.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
July 26 p. m. . . .	1.0324	5.0	9.12	8 Gals.
July 27 a. m. . . .	1.0326	3.7	8.90	12 Gals.

This is a good herd of cows, which are well cared for; it consists of two good grade Holsteins and seven that have Jersey blood in prominence mixed with unknown blood.

The heifer calves from the best cows are raised, and in this way a good herd of cows is being gotten together.

The wide variation in the morning's and evening's butter-fat test is due to the cows being milked so early in the afternoon. These cows are bred to freshen at no particular time of the year.

Each cow receives six pounds of cotton seed meal and six pounds of corn meal per day. L

HERD NO. 32.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
Aug. 12 p. m....	1.0320	4.9	9.00	7 Gals
Aug. 14 a. m....	1.0318	4.8	8.93	8 Gals.

This is a very common herd of cows, there being possibly traces of Holstein and Jersey in some of the cows, but the common stock blood predominates—consists of ten cows.

The barn is kept in very good shape, though it isn't ventilated or enough light allowed for the good health of the cows.

These cows are treated very gently, the milkers take a delight in being kind to them.

Most of the cows are bred to freshen in the winter.

Each cow receives about three pounds of cotton seed meal and three pounds of corn meal per day.

HERD NO. 33.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
Aug. 5 p. m....	1.0324	4.9	9.10	32 Gals.
Aug. 6 a. m....	1.0328	5.0	9.22	36 Gals.

This herd consists of thirty-eight cows, five of which are Holsteins with a mixture of some unknown blood, and thirty-three are Jerseys with a mixture of unknown blood.

This herd has been troubled with abortion considerably. The owner realizes the destructiveness of this disease and is taking steps to free his herd.

This is a herd of good producers, but it is altogether probable that it would do better if fed more grain. The cows are now receiving one and one-half pounds of cotton seed meal, one and one-half pounds of corn meal and five pounds of hulls each per day.

Most of these cows are bred to freshen in the spring.

HERD NO. 34.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
April 26 p. m. . .	1.0330	4.6	9.19	8 Gals.
April 27 a. m. . .	1.0338	5.2	9.51	8 Gals.

The writer might say that this herd of cows are not as good producers as the average herd in the vicinity of Hammond. It consists of thirteen cows, one of which shows evidence of Devon blood mixed with unknown breeding, and the remaining twelve show evidence of Jersey blood mixed with some unknown breeding.

The sanitary conditions of this dairy are not what they might be. The barn is an old one and is not kept as clean as it should be under the circumstances.

The animals are gently handled and fed very well, the only objection being that they are not fed according to the amount of milk produced.

Most of the cows freshen in the late winter and early spring.

Each cow receives three pounds each of corn meal, cotton seed meal and bran.

HERD NO. 35.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
May 20 p. m. . . .	1.0311	4.9	8.77	16 Gals.
July 31 a. m. . . .	1.0318	5.0	8.97	18 Gals.

There is no Holstein blood in this herd; it consists of twenty cows, all of which are Jerseys mixed with the ordinary scrub blood, consequently the butter fat test is above the average.

The sanitary conditions of this herd are very bad.

Most of the cows freshen in the late spring and early summer.

The feed consists of a mixture of equal parts cotton seed meal, corn meal and bran, eight pounds to each cow daily.

HERD NO. 36.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
May 7 p. m.	1.0327	4.6	9.11	40 Gals.
May 8 a. m.	1.0335	4.4	9.27	40 Gals.

This is a very good herd of cows; consists of three Holsteins with mixed breeding and forty-one Jerseys of mixed breeding.

This herd is well fed but is not handled as gently as they might be. The cows are also forced to walk a considerable distance to pasture every day, which cuts down the yield of milk to some extent. The cows, at the time this test was made, were receiving four pounds each of cotton seed meal, bran and corn meal per head per day.

Later in the season this herd changed hands and the same number of cows gave an average of more than two gallons each per day all through the summer and fall on less grain than is given above. This is due almost entirely to the difference in pasture. At the latter place they were turned on the range during the day, but instead of being kept in a dry lot at night, as they had been before, they were turned on a good crab grass pasture. Most of the cows freshen in the fall and spring.

HERD NO. 37.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
May 6 p. m. ...	1.0310	5.1	8.79	21 Gals.
July 20 a. m. ...	1,0319	4.8	8.95	25 Gals.

This is a herd of very good cows, as will be seen by the production; there are three good grade Holsteins and sixteen Jerseys mixed with other unknown blood. These cows are fed to the limit, each receiving seven pounds corn meal and seven pounds cotton seed meal per day.

The greatest objection to the management of this herd is that the owner does not give sufficient personal attention to the dairy, but entrusts the work almost entirely to hired help, which, in a large number of cases, is incompetent to care for and feed cows properly.

Most of these cows are bred to freshen in the spring.

HERD NO. 38.

Date of Test.	*Sp. Grav.*	*Fat.*	*Solids Not Fat.*	*Production.*
July 29 p. m....	1.0311	5.0	8.79	60 Gals.
July 30 a. m....	1.0317	4.4	8.82	70 Gals.

This herd consists of 120 cows, and practically all are Jerseys with a little mixture of some other unknown blood.

The sanitary conditions of this dairy are excellent and the cows are well fed, each receiving about eight pounds of a mixture of corn meal, cotton seed meal and bran per day, the amount depending upon the quantity of milk produced.

The reason for the production being so low in this herd is, in the opinion of the writer, mainly because the cows are improperly milked. Instead of each man having certain cows to milk and being held responsible for the proper performance of this operation, the milkers start at one end of the barn and take the cows as they come, and as a result each cow rarely ever has the same milker twice in succession. Then, too, the men are in a hurry to get through, and it is often the case that the cows are not milked out clean.

These cows are bred to freshen at no particular season of the year.

The Results of the Herds Tested are as Follows:

Average per cent of fat	4.54
Average per cent of solids not fat	8.96
Average per cent of total solids	13.50
Samples above 9.50 per cent solids not fat	2
Samples below 8.50 per cent solids not fat	3
Samples below 13 per cent total solids	12
Samples below 12.50 per cent total solids	2
Number of dairies	38
Number of milch cows, exclusive of dry stock	1027
Average number of cows in each dairy	27
Number of gallons produced daily	1582
Pounds of concentrated feed consumed daily	8832
Milk, gallons per day per cow	1.54
Price per gallon, cents	17
Income per day per cow, cents	26
Concentrated feed per day per cow, pounds	8.6
Daily feed cost, 8.6 pounds, at $27.50 per ton, cents	12
Daily profit per cow, not counting labor, interest on investment, insurance, or depreciation, cents	14

GRAVIMETRIC ANALYSES.

In order to test the accuracy of the methods used in the determinations made, a number of duplicate samples were analyzed gravimetrically by the Experiment Station at Baton Rouge. Total solids in samples 1 and 2 were determined at Baton Rouge gravimetrically, and the remainder sent to Hammond and tested by Wesphal balance. Total solids and samples 3 and 4 were determined by Westphal balance at Hammond and sent to Baton Rouge and determined gravimetrically. The following are the results:

Sample Number.	*Total solids using Westphal balance.*	*Total solids by gravimetric method.*
1	13.69	13.91
2	14.05	14.25
3	13.29	13.18
4	13.50	13.35
Average	13.63	13.67

HERD VARIATION.

In order to determine the daily variation in the test of different herds, samples were taken for seven days from three different sized herds. The results are as follows:

Herd No. 1*—55 Cows. Milks at 5 a. m. and 4 p. m.

Date.	Sp. Gr.	Fat.	SNF	Production.	Feed.	Weather.
Apr. 16, a. m.	1.0311	4.5	8.6'	355 lbs	....	Cloudy.
" p. m.	1.0307	4.5	8.58	305 "	....	Sultry.
" 17, a. m.	1.0312	4.1	8.63	358 "	C. S. meal, 3 lbs.	Raining.
" p. m.	1.0308	4.6	8.63	320 "	Cornmeal, 1 lb.	Sultry.
" 18, a. m.	1.0314	4.4	8.74	368 "	Hulls, 8 lbs.	Foggy.
" p. m.	Sample sour		....	297 "	per day.	Hot.
" 19, a. m.	1.0315	4.2	8.72	360 "	....	Cool, cloudy.
" p. m.	1.0311	4.9	8.77	312 "	....	Cloudy.
" 20, a. m.	1.0326	4.2	9.01	345 "	....	Cold rain during night.
" p. m.	1.0314	5.0	8.86	316 "	....	Cloudy.
" 21, a. m.	1.0326	4.0	8.96	370 "	*	Cold rain.
" p. m.	1.0313	5.2	8.88	296 "	†	Cold rain.
" 22, a. m.	1.0329	3.5	8.93	372 "	....	Cold rain.
" p. m.	1.0320	4.8	8.98	334 "	....	Cold rain.
Average per milking		4.45	8.80	336 lbs.	*Milked 45 minutes earlier than usual.	
Maximum variation from average		21 %	2.5 %	12 %	†Cows kept in night 21st.	

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*No. 27 in detailed report.

Herd No. 2†—31 cows. Milks at 4:30 a. m. and 4 p. m.

Date.	Sp. Gr.	Fat.	SNF	Production.	Feed.	Weather.
Apr. 24, p.m.	1.0323	4.4	8.97	225 lbs.	....	Fair.
" 25, a.m.	1.0325	4.8	9.10	226 "	Shorts, 1½ lb.	Partly cloudy.
" p.m.	1.0322	4.3	8.93	233 " *	C. S. meal, 1⅛ lb.	Rain, cloudy.
" 26, a.m.	1.0326	4.8	9.13	236 "	Hulls, 1 lb.	Rain in night.
" p.m.	1.0319	4.6	8.91	220 " †	Salt, 1 oz.	Fair.
" 27, a.m.	1.0321	5.0	9.04	220 " ‡		Foggy.
" p.m.	1.0319	4.7	8.93	205 "	Wet with 1 qt.	Fair.
" 28, a.m.	1.0323	4.8	9.05	226 " §	water and fed	Fair.
" p.m.	1.0319	4.0	8.78	222 "	twice daily.	Hot.
" 29, a.m.	1.0318	4.9	8.95	222 "	....	Foggy.
" p.m.	1.0317	4.4	8.82	226 "	....	Hot.
" 30, a.m.	1.0319	4.7	8.93	228 "	....	Warm, cloudy
" p.m.	1.0320	4.1	8.83	210 "	....	Warm, cloudy
May 1, a.m.	1.0324	4.8	9.08	227 "	....	Cloudy, rain.
Average per milking ..		4.6	8.96	222 lbs.	*One-half usual amount salt.	
Maximum variation					†No salt.	
from average		13 %	2 %	7.66 %	‡Milked 20 minutes late.	
					§Sample taken at weigh can.	

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†No. 14 in detailed report.

Herd No. 3*—13 cows. Milks at 4:30 a. m. and 4 p. m.

Date.	Sp. Gr.	Fat.	SNF	Production.	Feed.	Weather.
Apr. 23, p.m.	1.0330	4.9	9.25	58.5 lbs.	C. S. meal 3 lbs	....
" 24, a.m.	1.0337	5.4	9.53	66 "	Corn and	....
" p.m.	1.0330	4.9	9.25	58.5 "	Cob meal 3 "	Fair.
" 25, a.m.	1.0333	5.0	9.36	58 "	Bran . . 3 "	Partly cloudy.
" p.m.	1.0333	4.4	9.22	68 "	....	Rain.
" 26, a.m.	1.0335	5.2	9.43	64 "	....	Cloudy, rain during night
" p.m.	1.0330	4.6	9.19	57 "	....	Fair.
" 27, a.m.	1.0338	5.2	9.51	60 "	....	Foggy.
" p.m.	1.0329	4.4	9.12	58 "	....	Fair.
" 28, a.m.	1.0329	5.5	9.34	61 "	Dropped corn and cob meal for rest of period.	Fair.
" p.m.	1.0325	4.6	9.06	58.5 "		Hot.
" 29, a.m.	1.0325	4.9	9.12	61 "		Foggy.
" p.m.	1.0327	4.5	9.09	56 "		Hot.
" 30, a.m.	1.0330	5.5	9.38	57 "	....	Warm, cloudy
Average per milking..		4.9	9.27	60 "		
Maximum variation from average..........		12%	2.8%	13%		

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*No. 34 in detailed report.

WEEKLY AVERAGE OF THE TESTS OF THESE HERDS.

No. of herd.	*Fat, per cent.*	*Solids not fat, per cent.*	*Milk production pounds.*
1	4.45	8.80	336
2	4.6	8.96	222
3	4.9	9.27	60
Average....	4.65	9.01	206

It will be seen from these tables that the variation of solids not fat from milking to milking is very slight; that the weather apparently has little to do with the test, and that the test does not vary uniformly with the production.

VARIATION IN INDIVIDUAL COWS.

The following are the results of tests made to determine the variation of individual cows. These cows were all pure bred Red Polls and had been fresh only a short time.

Cow No. 1.

P. M.					A. M.				
Date.	Sp. Gr.	Fat.	SNF	Weight of Milk.	Date.	Sp. Gr.	Fat.	SNF	Weight of Milk.
May 15	No sample taken.			7.7 lbs.	May 16	1.0327	4.0	8.98	8.5 lbs.
“ 16	1.0333	4.2	9.18	7.2 “	“ 17	No sample taken.			
“ 17	1.0329	3.8	8.99	7.8 “	“ 18	1.0330	4.1	9.08	9.2 “
“ 18	1.0327	4.4	9.07	7.5 “	“ 19	1.0332	3.9	9.09	9.2 “
“ 19	1.0332	4.3	9.18	7.5 “	“ 20	1.0333	4.0	9.14	10.1 “
“ 20	1.0322	3.9	8.84	7.7 “	“ 21	1.0302	4.9	8.54	10.0 ‘
“ 21	1.0313	5.0	8.84	7.2 “	“ 22	1.0312	5.3	8.88	10.0 “
Average for week							4.3	8.98	8.4 “
Maximum variation from average							23%	4.9%	20%

Cow No. 2.

P. M.					A. M.				
Date.	Sp. Gr.	Fat.	SNF	Weight of Milk.	Date.	Sp. Gr.	Fat.	SNF	Weight of Milk.
May 15	1.0315	4.5	8.79	6.3 lbs.	May 16	1.0325	4.1	8.95	7.2 lbs.
“ 16	1.0321	4.4	8.92	5.5 “	“ 17	No sample taken.			
“ 17	1.0314	4.4	8.74	6.3 “	“ 18	1.0312	5.0	8.81	6.0 “
“ 18	1.0307	5.3	8.75	5.2 “	“ 19	1.0309	4.6	8.65	6.3 “
“ 19	1.0301	5.3	8.60	5.5 “	“ 20	1.0309	4.8	8.69	7.5 ‘
“ 20	1.0314	4.4	8.74	6.2 “	“ 21	1.0305	4.9	8.61	7.5 “
“ 21	1.0299	5.6	8.61	6.1 “	“ 22	1.0314	4.6	8.78	7.0 “
Average for week							4.8	8.74	6.35 “
Maximum variation from average							17%	2.4%	18%

Cow No. 3.

P. M.					A. M.				
Date.	Sp. Gr.	Fat.	SNF	Weight of Milk.	Date.	Sp. Gr.	Fat.	SNF	Weight of Milk.
May 15	1.0321	3.7	8.77	6.0 lbs.	May 16	1.0346	3.4	9.35	6.7 lbs.
“ 16	1.0338	3.4	9.15	5.5 “	“ 17	....	....	....	....
“ 17	1.0334	3.4	9.04	6.3 “	“ 18	1.0339	4.1	9.31	6.5 “
“ 18	1.0327	3.8	8.94	5.5 “	“ 19	1.0340	3.8	9.28	6.6 “
“ 19	1.0332	4.1	9.13	5.9 “	“ 20	1.0327	4.1	9.00	8.0 “
“ 20	1.0326	4.1	8.98	6.6 “	“ 21	1.0326	4.1	8.98	7.6 “
“ 21	1.0324	4.1	8.93	6.4 “	“ 22	1.0330	4.0	9.06	7.6 “
Average for week							3.86	9.07	6.6 “
Maximum variation from average							12%	3.3%	21%

Cow No: 4.

P. M.					A. M.				
Date.	Sp. Gr.	Fat.	SNF	Weight of Milk.	Date.	Sp.Gr.	Fat.	SNF	Weight of Milk.
May 15	1.0323	4.0	8.88	8.3 lbs.	May 16	1.0331	3.5	8.99	9.0 lbs.
" 16	1.0329	3.8	8.99	6.9 "	" 17	No sample taken.			....
" 17	1.0322	3.8	8.82	8.2 "	" 18	1.0322	4.3	8.93	8.3 "
" 18	1.0327	3.8	8.94	6.3 "	" 19	1.0319	4.3	8.85	8.6 "
" 19	....	......	....	....	" 20	1.0317	4.2	8.77	10.1 "
" 20	1.0319	4.6	8.91	7.1 "	" 21	1.0308	4.0	8.51	9.0 "
" 21	1.0310	4.6	8.68	7.1 "	" 22	1.0313	4.2	8.67	8.9 "
Average for week							4.1	8.83	8.2 "
Maximum variation from average							14.6%	3.6%	23%

Cow No. 5.

P. M.					A. M.				
Date.	Sp. Gr.	Fat	SNF	Weight of Milk.	Date.	Sp. Gr.	Fat.	SNF	Weight of Milk.
May 15	1.0331	4.3	9.15	6.7 lbs.	May 16	1.0324	4.5	9.02	8.0 lbs.
" 16	1.0327	4.4	9.07	5.7 "	" 17	No sample taken.			....
" 17	1.0332	4.0	9.11	6.9 "	" 18	1.0321	5.4	9.13	7.4 "
" 18	1.0325	4.5	9.04	5.9 "	" 19	1.0321	4.9	9.02	7.8 "
" 19	1.0320	5.3	9.08	6.3 "	" 20	1.0318	4.8	8.93	6.3 "
" 20	1.0322	4.9	9.05	6.2 "	" 21	1.0310	5.1	8.79	7.7 "
" 21	1.0313	5.3	8.90	6.6 "	" 22	1.0311	5.0	8.79	7.5 "
Average for week							4.8	9.01	6.85 "
Maximum variation from average							17%	2.4%	17%

WEEKLY AVERAGES OF THE INDIVIDUAL COW TESTS.

No. of cow.	*Fat.*	*S. N. F.*	*Production, lbs.*
Cow No. 1	4.3	8.98	8.4
Cow No. 2	4.8	8.74	6.35
Cow No. 3	3.86	9.07	6.6
Cow No. 4	4.1	8.83	8.2
Cow No. 5	4.8	9.01	6.85
Average	4.37	8.93	7.28

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Agricultural Experiment Station

OF THE

Louisiana State University
and A. & M. College,

BATON ROUGE.

INVESTIGATIONS ON THE USE OF

Sulphur and Its Combinations

IN THE SUGAR HOUSE.

FRITZ ZERBAN, Ph. D.

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PREFACE.

The investigations forming the subject of this bulletin were undertaken during the past two grinding seasons and the summer of 1907. They were brought on by a conference held in Washington, D. C., on October 30, 1906, between representatives of the Louisiana sugar industry and the authorities charged with the enforcement of the Food and Drugs Act, in regard to the use of certain chemicals employed in the manufacture of sugar products. Dr. Wiley, at that time, objected mainly to the use of sulphur fumes, but stated that this process would probably be permissible if the percentage of sulphur as sulphites in the final products did not exceed 350 milligrams per kilo or 0.035 per cent. This necessitated a thorough study of the sulphitation process with the view of finding out how much sulphur dioxide is left in the final products, if a certain quantity of sulphur be used for clarification, and how it will be possible to keep within the limit indicated by Dr. Wiley. At the same time the use of other clarifying agents was studied from a similar standpoint.

Further hearings were held in Washington with the object of securing a definite ruling on these points. Finally, Food Inspection Decision No. 76 was rendered, restricting the percentage of sulphur dioxide to 350 milligrams per kilo. But this decision has not been enforced so far, having been suspended by action of the President of the United States. A board of five has been appointed, selected from chemical and medical experts of leading scientific institutions in the country, to render their opinion on the questions involved. The data collected by our investigations give a definite idea of the composition of our products as made with the proper use of the sulphitation process, and may be helpful in considering the legitimacy of the methods of manufacture practiced in the Louisiana sugar industry.

The writer wishes to extend his sincere thanks to Mr. R. E. Blouin, who proposed this investigation, and to Dr. W. C.

Stubbs, for the great interest shown by them in these studies, and for many valuable suggestions.

Thanks are also due to Mr. H. P. Agee, who supervised the sugar house work, and to Messrs. J. A. Hall, Jr., W. P. Naquin and P. H. Doherty, who carried out a large amount of laboratory work, which is highly appreciated.

Dr. Stubbs and Mr. William Beer, Librarian of the Howard Memorial Library, assisted me very kindly in my search for literature on the subject.

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INTRODUCTION.

Methods of Clarification Used in Louisiana from the Chemical, Economical and Legal Standpoint.

About thirty years ago very little was known about those substances which, besides sugar itself, enter into the composition of sugar cane juice. Certain organic acids had been found, also albuminoid, fatty and mineral matter. Only careful studies extending over a number of years have brought some light into the chaos of substances constituting the non-sugar of the cane. A great number of workers have contributed to this field of research, mainly Winter, Szymanski and Prinsen-Geerligs in Java, Shorey in Hawaii, Maxwell, Beeson and Browne in Louisiana. The investigations carried out by these men and by a number of others have shown, that while sucrose is the principal solid constituent of cane juice, a great number of inorganic and organic substances occur in it. They are generally classed as "impurities" of the juice. As the principal ones may be mentioned: albumen, nuclein bodies, albumoses, amido acids, amids, dextrose and levulose, pectin bodies, fat and wax, tannin, coloring substances, a number of inorganic and organic acids and of mineral bases. From a solution of sugar in water we can obtain all of the sugar by evaporation under proper physical conditions. But if we take cane juice with all the impurities mentioned in it, and evaporate it even under the best physical condition, we finally obtain only a small percentage of the sugar originally present in the juice. This shows very clearly that the impurities coexisting with the sugar either destroy sugar or prevent its crystallization. In order to prevent this loss, the cane juice must be "clarified." The object in view is to completely remove all impurities, leaving behind a solution of pure sucrose in water. A process which will satisfactorily answer this purpose, has not yet been discovered and may never be found, owing to the diverse nature of the impurities in cane juice.

Heat alone eliminates a small portion of the impurities, mainly of the albuminoids, gums and inorganic salts, amounting to about 0.25-0.50 per cent.[1] But the free acids of the juice are not removed, and the high temperature only assists them in their destructive work on the sugar which is inverted into dextrose and levulose. It is therefore necessary to neutralize the acids before heating. The oldest and cheapest method for accomplishing this purpose is the addition of caustic lime to the cane juice previous to heating. This was practiced in Egypt about 1,200 years ago, and probably even long before that time, and is still the most common method of procedure for the clarification of cane juices.

By the addition of lime to cane juice, the organic acids are neutralized, the albuminoids are almost quantitatively removed, the gums, sulphates and phosphates partly precipitated, and all mechanical impurities are carried down by the precipitate.

This process is practiced to a small extent in Louisiana. Under average conditions about 0.6 pound of lime per ton of cane is required to neutralize the acids. However, this amount varies considerably with the composition of the juice. The natural acidity of the juice must be determined in each case and the calculated amount of lime added to just nearly neutralize the acid. This is all the more necessary, since overliming exerts the most disastrous influence on juices high in reducing sugars, which is always the case in Louisiana. In the tropics, where the cane juice contains only a small percentage of glucose, the effect of an excess of lime is less marked. If we allow our Louisiana juices to become alkaline, the glucose is converted into glucinic and saccharic acids, which, on heating, render the juice so dark as to considerably injure the appearance of the products. Furthermore, they increase the viscosity of the juice and syrup to such an extent that boiling to grain becomes very difficult. Another danger consists in the fact that in consequence of the formation of glucinic and saccharic acids the juice turns acid on heating, thus causing the inversion of a portion of the sucrose. But even if the juice is only just neutralized, it darkens considerably during further treatment and only low grade products can be obtained which must of necessity be refined before marketing.

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[1] Agee and Hall, Bull. 91. La. Agr. Exp. Stat., 35.

A great number of processes have been tried with the view of improving the method just described and something like three hundred chemicals or combinations of chemicals have been proposed for this purpose. Of many of these it was claimed that they would entirely revolutionize the sugar industry, but only a few of them have after a thorough trial maintained their place in the sugar house. These are carbon dioxide, phosphoric acid and sulphurous acid.

All of these are used in combination with lime, and there are two possible ways of doing this:

1. Adding an excess of lime to decided alkalinity and bringing this back to neutrality with one of the acids named (Alkaline Clarification).

2. Adding a certain quantity of acid to the juice and then neutralizing with lime (Acid Clarification).

1. In the manufacture of sugar from beets which contain practically no glucose, methods based on the first principle are generally used. The juices are first treated with a large excess of lime, and then carbonic acid is passed into the heated juice, usually in two operations, between which the juice is filtered. The second carbonitation is often partly or wholly replaced by a treatment with sulphur dioxide. Similar methods are used in some cane sugar factories in Java where the cane is very low in reducing sugars. But they cannot at all be recommended in such countries which lie near the border line of the cane sugar belt. In these countries the high percentage of reducing sugars prevents the use of alkaline clarification, as has been shown above.

There is one modification of alkaline clarification, however, which almost entirely avoids those difficulties. It consists in the addition of an excess of lime at a *low temperature* and bringing back to neutrality or slight acidity with phosphoric acid. This method has been found to give good results, but it offers no advantages over the sulphitation process described below, especially if the price of phosphoric acid be taken into consideration.

2. The object of acid clarification is to remove a part of

the impurities and to decolorize the juice by the addition of an acid and to afterwards neutralize with lime. The two acids that may be used for this purpose are phosphoric and sulphurous acids.

In the first of these two methods about 1.63 pounds of concentrated phosphoric acid should be used per ton of cane and the juice should then be neutralized by the addition of about 1.9 pounds of lime per ton of cane. These figures are, of course, calculated for average conditions and may vary considerably.

If this process be properly conducted it gives very good results. But two factors prevent its general adoption; first, the price of phosphoric acid, and second, the fact that very often phosphates separate out in the molasses, rendering it turbid and reducing its market value.

There remains one more method, the sulphitation process, which will be discussed a little more fully, because it has proven to give the best results with Louisiana juices. It has been thoroughly studied by Dr. Stubbs and his collaborators, and the final results of their investigations are expressed in Bulletin No. 91 of the Station, by C. A. Browne and R. E. Blouin. The conclusions arrived at read as follows:

"As a general summary of the foregoing experiments upon alkaline and acid clarification, we may say that for Louisiana conditions, where the juices usually contain a high percentage of reducing sugars as compared with tropical countries, a carefully conducted sulphitation gives the most satisfactory results from the point of economy, as well as from the favorable outturn of sugar.

"From the two foregoing tables it is evident that the best sulphur lime clarification is obtained by sulphuring strongly, then liming to neutrality."

The proper use of the sulphitation process is not at all an easy or simple matter. Sulphur dioxide being a gas cannot be weighed by ordinary means, and the quantity that is actually absorbed by the juice can be accurately determined only by chemical methods. For this reason the use of bisulphite of lime or of soda has been proposed; but they do not give the same effect as sulphur dioxide, because they do not increase the acidity sufficiently unless a very large quantity be used.

On an average about 0.7 pounds of sulphur and 2 pounds of lime per ton of cane should be used, the quantities varying from case to case with the composition of the juice.

The effect of sulphur dioxide is threefold. It removes impurities, decolorizes the juice, and, to some extent, prevents fermentation.

Sulphur dioxide alone precipitates about 75 per cent of the proteid and pectin bodies, a large portion of the mineral matter and the fat and wax.

All acids decolorize cane juice to some extent, but on neutralizing with alkali the original color is restored. This phenomenon is similar to the well-known action of acids and alkalies upon so-called indicators, like litmus or phenolphthalein. The latter is perfectly colorless in an acid solution, but at once turns red after the addition of the slightest excess of alkali. Cane juice contains organic compounds that behave similarly to these substances, and this explains the effect of acids and alkalis on the juice. But sulphur dioxide, besides acting in the manner just described, exerts a peculiar effect upon some of the organic constituents of cane. It actually bleaches them, most probably by forming colorless compounds with them or by removing oxygen from them, and the new substances remain colorless as long as there is sulphur dioxide present in sufficient quantity. In the course of time the sulphur dioxide is oxidized to some extent by the oxygen of the air, and the color of the organic compounds is partly restored.

The third property of sulphurous acid which renders it most useful in the preservation of meat, fruits and wine, namely, its antiseptic effect, is of only small importance in the sugar industry, because the juices are always heated so soon after their extraction that microorganisms cannot do it any harm. Only in very rare cases, where the juices must be left standing for some time owing to a breakdown, the addition of sulphurous acid to the juice offers the further advantage of preventing fermentation.

All these properties render sulphurous acid, in combination with lime, the best clarifying agent for Louisiana cane juices. However, it must be used very carefully and neglect of this precaution may bring about great losses in sugar and money. Sulphurous acid, like all other acids, has the property of splitting of sucrose into reducing sugars by inversion; in fact, it ranks fourth in the list of acids arranged by their inverting power. Inversion increases with the concentration of the acid, with the temperature and with the time. For these reasons sulphur dioxide must be applied at as low a temperature as possible and a large excess must be avoided. On the other hand, a sufficient quantity must be used to remove the largest possible quantity of impurities and to bring about the desired bleaching effect. The exact point which gives the best results must always be determined by experiment.

After the required amount of sulphur dioxide has been added, the juice must at once be brought back to faint acidity, in order to avoid losses from inversion. Great care must be taken not to add an excess of lime, because this would again result in losses, as pointed out above. If all these points are carefully observed, there is no difficulty in the further treatment of the juice.

The methods described are the principal ones used in the cane sugar industry. It will now be necessary to find out to what extent these different processes are used in Louisiana and for what reasons.

The following chemicals or combinations of chemicals are employed in Louisiana sugar houses: Lime alone; lime and carbonic acid; lime and phosphoric acid; sulphur dioxide and lime; sulphur dioxide, lime and phosphoric acid.

The first, second, third and fifth of these processes are used only to a limited extent, and the great majority of factories use the ordinary sulphitation process.

The reasons for this are obvious. The planters in Louisiana are compelled to make fancy sugars for direct consumption to keep independent of the trust. In the second place, molasses and syrups are at present sold mainly on color. The one and only process that enables the planters to manufacture all these products profitably, is sulphitation.

The next question is: Are these processes in accordance with the regulations of the Pure Food Law?

The sections of the Food and Drug Act which are applicable to sugar house products, read as follows:

> "Be it enacted—
>
> "Section 7. That for the purpose of this Act an article shall be deemed to be adulterated—
>
> "In the case of food:
>
> "First. If any substance has been mixed or packed with it so as to reduce or lower or injuriously affect its quality or strength.
>
> "Fourth. If it be mixed, colored, powdered, coated or stained in a manner whereby damage or inferiority is concealed.
>
> "Fifth. If it contain any added poisonous or other added deleterious ingredient which may render such article injurious to health."

In order to find out whether the processes used at present in our Louisiana sugar houses are in accordance with these regulations, we have to answer the following questions:

> Ad 1. Does a sufficient quantity of the reagents used in clarification remain in the final products to lower their quality or strength?
>
> Ad 4. Are any chemicals added in the manufacture of sugar with the purpose of concealing the inferiority of the products?
>
> Ad 5. Are any poisonous or deleterious substances, not subsequently removed, used which may render the products injurious to health?

The second of these questions can at once be answered in the negative. The other two, however, will require a more careful examination.

No objection can possibly be raised, from the standpoint of the Pure Food Law, to the clarification with lime alone. Lime is a natural constituent of the cane and has no harmful effect whatever in the form of those salts that are found in our products. Although the percentage of lime is higher in the molasses than in an equivalent quantity of raw cane juice, it is not sufficiently large to materially reduce its quality or strength. The same is true for the sugar made by this process.

Carbonic and phosphoric acids are, in combination with lime, used only in a very few houses in Louisiana. The carbonic acid introduced into the juice is entirely removed during the process of manufacture, since the juices are still slightly alkaline after treatment with carbonic acid and turn acid during further heating, as has been described above.

The phosphoric acid appears in the final products in the form of phosphates of alkali or lime. But phosphates are, like lime, natural constituents of cane juice. The quantity of these in the final products is very small, certainly not large enough to be objected to on the ground of the Pure Food Law.

The very best method of clarification which is almost universally used in Louisiana, the sulphitation process, has been most severely criticized by the authorities charged with the enforcement of the Pure Food Law, and Food Inspection Decision No. 76 restricted the percentage of sulphur dioxide in the final products to 350 milligrams per kilo. The enforcement of this decision has, however, been suspended, upon demonstrations made by representatives of the Louisiana sugar industry, and an investigation of the case has been carried out by the Department of Agriculture. Chemical and physiological studies on the same question have also been made by the Louisiana Sugar Experiment Station and by the Louisiana State Board of Health, and the results of the chemical part of this work are given in full in the following chapters of this bulletin.

In connection with these experiments, two new clarifying agents were tried, hydrosulphite and camorsite. They will also be discussed as to their practical merits and from the standpoint of the Pure Food Law.

Salts of tin and zinc have at times been used as a wash in the centrifugals or in the refining of molasses. Both metals form compounds which are more or less harmful, and they will also be taken up in a separate chapter.

Investigations on the Use of Sulphur and Its Combinations in the Sugar House.

BY FRITZ ZERBAN, PH. D.

SHORT HISTORY OF THE SULPHITATION PROCESS IN LOUISIANA.

Proust was the first to propose the use of sulphite of lime in the sugar industry, in 1810.[1] Drapiez[2] (1811) and Perpère[1] (1812) tried sulphur dioxide for the same purpose, but they failed. Dubrunfaut[3] took up the experiments again in 1829, and was granted a patent. But his process was not a success, because he had overlooked some factors playing an important part in the action of sulphur dioxide on saccharine juices. Stollé's (1838) and Merge's processes, employing bisulphite of lime, and Boulin's method (1846) with sulphite of alumina, failed for the same reason.[1]

Scoffern[4] found in 1847, apparently without knowledge of these French patents, that any excess of lime used in the defecation of cane juice could be neutralized and precipitated by introducing sulphur dioxide into the juice. But this observation passed unnoticed, because Scoffern, convinced that lime was not a desirable clarifying agent, advocated the use of lead acetate and the subsequent removal of any excess of this reagent with sulphur dioxide.[5] This latter process never has been adopted on account of the danger to public health connected with it.

Up to the year 1849 sulphur dioxide or bisulphite of lime were only occasionally used in sugar factories, not as clarifying agents, but only to check fermentation of juices.[6] In that year Melsens[7] carried out an extensive investigation on the use of sulphur dioxide and sulphites in the sugar factory, and came to the conclusion that bisulphite of lime employed in combination with lime gave excellent results as a clarifying agent, but that the use of sulphur dioxide was dangerous, and that of neutral sulphite of lime ineffective. The publication of his researches created a big sensation in the sugar world. This can easily be seen from the fact[1] that the American Chargé d'Affaires in Brussels, T. G. Clemson, sent a translation of Melsen's paper to the Secretary of State with a recommendation. Already during the following grinding season (1850) Melsen's process was given a trial on several plantations in Louisiana. Lyman and Todd, Thom. A. Morgan and some other planters met with decided success.[2] Others, however, do not seem to have obtained good results, as may be seen from a statement in Valcour Aime's diary,[3] to the effect that although good sugar was made with bisulphite, the method had to be abandoned, because his filters did not work well, when bisulphite was used. Trial experiments made in Gouadeloupe about the same time were also unsuccessful.[4] But the obstacles were soon overcome by Melançon in Louisiana,[5] and from the year 1853 the process seems to have been adopted by a good many planters. In 1854 Ulger Lauve[5] erected a bisulphite factory in New Orleans, and H. Bonnabel and two others soon followed his example.

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[1] De Bow's New Orleans Review, Vol 8, 306 (1850).

[2] Bull. de la Societe d'Encouragement, 10, 56.

[3] Walkoff, Traite complete de la fabrication du Sucre, Vol. 1, 114.

[4] De Bow's Review, 9, 637.

[5] De Bow's Review. 10, 47.

[6] De Bow's Review, 6, 177.

[7] De Bow's Review, 8, 307.

Col. Stewart[6] showed in 1858 that the planters, instead of buying the bisulphite ready made, could practically obtain the same results by passing sulphur dioxide, made from sulphur in the sugar house, into the juice and subsequently neutralizing with lime. From this time on both bisulphite of lime and sulphur dioxide were used in Louisiana, the latter gaining more and more favor. It was reported in 1869[7] that of two planters living 44 miles above New Orleans, one who made white refined sugar with bone black, sold for 15-16 cents per pound, while the other received 14½ cents for yellow clarified made with sulphur.

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[1] Hedge, Free & Co.'s Treatise on Sugar Cane, page 71, 1859.

[2] De Bow's Review, 8. 491, and 9, 417.

[3] Page 141.

[4] De Bow's Review, 10, 566.

[5] Ulger Lauve, on the Use of Bisulphite of Lime. page 8.

[6] Sugar Cane, 4, 631.

[7] De Bow's Review, 37, 91.

But the results obtained with sulphur dioxide were not always equally good. Only the very thorough investigation of Battut in France, undertaken in 1884, cleared up all the points which up to that time had not been fully understood. The application of the principles established in his work, by W. C. Stubbs, and his coworkers, finally led to the establishment of a perfect sulphitation process for cane juices.

It may be mentioned in this connection that Dr. Icery, of Mauritius,[2] introduced the use of bisulphite of lime into that colony around 1865, for a very remarkable reason. Most of the sugar made in Mauritius goes to India, and the Hindoos refused to consume sugar manufactured with the aid of bone black, because this is made from the body of a venerated animal. Sulphitation is also used to some extent in Reunion, Guadeloupe, Demerara, Peru and other Central and South American countries.

The use of bisulphite of lime decreased more and more in Louisiana and it is now entirely replaced by sulphur dioxide.

The chemical side of the process as it is now worked, has already been outlined in the preceding chapter and certain points of special importance for this study will be discussed in detail further on.

The sulphur dioxide used for the process is always prepared at the factory by burning sulphur in stoves of various constructions, usually with the aid of compressed air, for which a special pump is provided. The formation of sulphuric acid by further oxidation of the sulphur dioxide is prevented by cooling the sulphur dioxide pipe with water.

There are three ways of introducing the sulphur dioxide into the juice. The simplest method is to have the sulphur dioxide pipe terminate into the juice pipe carrying the mill juice to the clarifier. In this case the juice remains in contact with the sulphur dioxide only for a very short period. If it be intended to have it act longer, special arrangements must be provided for. One of these methods is to pump the mill juice into a tank. The sulphur dioxide enters into this tank through perforated pipes placed at the bottom. In this case the sulphur dioxide can be made to act upon the juice for any desired length of time and the juice can be sulphured to any degree of acidity up to its full capacity. The third method is to mix the sulphur dioxide with the juice in a so-called sulphur box, provided with shelves, leaving an opening on alternate sides. The juice is allowed to flow down over these shelves, and the sulphur dioxide enters at the bottom, the excess of it escaping on top of the box. The sulphitation can in this case be regulated by changing the velocity of the juice flow, and the quantity of sulphur dioxide introduced within a certain period of time.

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[2] See page 16, 6.

All of these methods are used in Louisiana sugar houses. The second of them is employed at the Sugar Experiment Station, because it affords a perfect control of the sulphitation.

REVIEW OF THE LITERATURE ON THE PHYSIOLOGICAL EFFECTS OF SULPHUROUS ACID.

Since the first experiments of Bernatzik and Braun, made in 1869, a number of investigations have been carried out on the effects produced by the administration of sulphur dioxide and sulphites. In some cases cats or dogs were used in the experiments, in others human beings. Most of the investigators, with the exception of Liebreich and a few others, came to the conclusion that sulphur dioxide and sulphites are liable to cause headache, eructations of sulphur dioxide, in some cases vomiting or diarrhœa. On clinical examination inflammatory changes of the kidneys were found after an administration of daily doses of sodium sulphite with meat for a period of twenty weeks.

The most extensive study of the effect of sulphur dioxide and sulphites on the human system was made by the United States Department of Agriculture under the direction of Dr. H. W. Wiley. The conclusions arrived at by him read as follows:[1]

"It appears that the administration of sulphurous acid in the food, either in the form of sulphurous-acid gas solution or in the form of sulphites, is objectionable and produces serious disturbances of the metabolic functions and injury to digestion and health. This injury manifests itself in a number of different ways, both in the production of clinical symptoms which indicate serious disturbances, malaise, or positive suffering, and also by inducing certain changes in the metabolic processes which are not manifested in the way of ordinary clinical symptoms, and are only detected by careful chemical and microscopical study of the excretory products. It can be safely said from the evidence adduced that the administration of sodium sulphite and sulphurous acid, as above indicated, produces a marked influence of an unfavorable character on metabolism."

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[1] Circular No. 37, Bureau of Chemistry, 16.

"The conclusion is inevitable that as a whole the changes produced in metabolic activity by the administration of sulphur in the forms noted above in the comparatively short time covered by the experiments are decidedly injurious. The verdict which must be pronounced in this case is decidedly unfavorable to the use of this preservative in any quantity or for any period of time, and shows the desirability of avoiding the addition of any form of sulphurous acid to products intended for human food."

The results of all investigations on sulphur dioxide and sulphites show that these substances may produce a harmful effect upon the system.

However, they cannot at all be applied to our Louisiana syrups and molasses. So far it has not been proven that these products contain any sulphur dioxide or sulphites. The sulphur dioxide that is found, when our products are subjected to analysis, can all be accounted for by the decomposition of certain organic substances occurring in sugar products made by sulphitation.

These substances are formed by the action of sulphur dioxide upon certain organic compounds, mainly aldeydes. They do not contain sulphur dioxide at all; but since sulphur dioxide may be regenerated from them by certain chemical processes, the sulphur dioxide thus obtained is usually termed "combined sulphur dioxide," while sulphur dioxide gas itself or that in combination with inorganic bases, like potash or lime, is termed "free sulphur dioxide."

Ripper[1] showed a number of years ago that the greater part of the sulphur dioxide in sulphured wines does not occur in its ordinary form, *i. e.*, as sulphur dioxide itself or its mineral combinations, but that it exists there in some other combination with its properties entirely changed. The exactness of this observation was corroborated by a number of investigators.

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[1] Jour. Prakt. Chemie, 46, 428.

Kerp and Farnsteiner,[2] working at the German Imperial Department of Health, proved conclusively that sulphurous acid added to wines reacts with the acetaldeyde of the wine and forms a new compound, acetaldelyde-oxysulphonic acid. The same authors further found that similar compounds are formed by the entire group of organic substances, called aldelydes, to which also belongs dextrose, or glucose. All these new substances have properties entirely different from those of sulphur dioxide itself. While sulphur dioxide itself and sulphites of mineral bases are strong reducing agents and therefore take up oxygen very rapidly when exposed to the air, the oxysulphonic acids and their salts are perfectly stable, and do not change at all in dry air. The difference between "free sulphur dioxide" and "combined sulphur dioxide" is very strikingly shown by the behavior towards iodine solution of sulphites and oxysulphonates. The former are easily oxydized, the latter are not. This phenomenon enables us to distinguish between the two.

Not only aldehydes or aldehyde sugars form such compounds, but other carbohydrates and proteid bodies seem to react in a similar manner. All these organic combinations of sulphur dioxide may conveniently be termed oxysulphonates, although we do not know the exact composition of some of them.

If oxysulphonates be dissolved in water, they are partly decomposed into the aldehyde on the one hand and sulphite on the other. This dissociation increases with the dilution and with the temperature. The degree of dissociation at equal concentrations is not the same for different oxysulphonates. The acetaldehyde-oxysulphonate dissociates to a smaller extent than the glucose oxysulphonate. The amount of dissociation can in each case be determined by the quantity of iodine absorbed by the solution.

Free acids retard the dissociation of oxysulphonates. This phenomenon is most marked in the case of the glucose oxysulphonate and is a very important factor in judging the physiological properties of Louisiana syrups and molasses which are always decidedly **acid.**

Rost and Franz[1] have carried out investigations on the physiological effects of oxysulphonates, using aqueous solutions of the sodium salts, and have found that the oxysulphonates as such have no toxic properties whatever, but that their physiological effect is in proportion to the free sulphur dioxide formed by dissociation. If they be administered in acid solutions they are less effective than if given in water solutions, and this is especially true of the glucose compound. This is again in perfect agreement with the result of the chemical experiment.

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[1] Arbeiten aus dem Kaiserl: Gesundheitsamt, 21, 312, 371.

[2] Ztschr. Unters. Nahrungs— u. Genussm., 6, 66: 7, 49: 8, 53.

Rost and Franz have drawn the following conclusion from their experiments: The poisonousness of a certain oxysulphonate can be directly determined by its iodine absorption. The effect of glucose-oxysulphonates depends very largely on the composition of a certain food product and even on the conditions under which it is ingested.

The following chapters will show what physiological effects we can expect from the chemical examination of our products.

But a practical test has already been made of the effects upon the human system of Louisiana manufactured syrups and molasses. This investigation was carried out by the Louisiana Sugar Experiment Station in co-operation with the Louisiana State Board of Health. A detailed account of these experiments has been issued as Bulletin No. 94 of the Louisiana Experiment Stations, and the conclusions arrived at read as follows:

"1. From a practical standpoint the experiments on molasses feeding were carried on for a sufficient length of time and on a scale large enough to test the effects of these foods on the human subject in ordinary health.

"2. We believe that our mode of examination is the fairest way to test the effects of substances on the human subject under natural conditions, for here we had a large number of docile and ignorant men who did not know what was expected of them, were neither frightened nor awed, and put in the same condition as persons who partake of molasses as a food, eating of the same according to their taste and liking, and the effects on them carefully and faithfully noted from day to day and week to week.

"3. As in none of our cases were the body functions interfered with in each one the body weight increased, and as the blood steadily increased in number of red blood cells, in the percentage of hæmoglobin, etc., it must be admitted that these subjects were gaining in health and neither doing nor taking anything prejudicial to their physical well-being.

"4. A careful survey of Table XX, on weights, and of Tables VII to XVII, on blood examination, will satisfy any one that the subjects gradually improved in weight, body functions and blood conditions, notwithstanding the fact that during Periods II, III, IV they daily took a considerable quantity of syrup or molasses containing appreciable quantities of sulphur as sulphites.

"Reference to Tables III, XIX, XX, and VII to XVII, will demonstrate that the amount of molasses consumed, although in some instances very large, does not seem to have had any deleterious effects on the functions, weight and blood condition of the subjects, but rather to the contrary.

"We are, therefore, free to conclude that molasses feeding, even when said molasses contains as high as over 900 milligrams per kilo of sulphur as sulphites, can be carried on under ordinary circumstances without prejudicial effect to health."

Two objections mainly have been raised in criticizing these investigations.

It has been said that one molasses made without the use of sulphur should have been used for comparison. This criticism would be justified if any harmful effects had at all been noticed with the products used. Since this was not the case, such a comparison was unnecessary.

In a few cases the subjects complained of slight diarrhœa and this fact has been used to discredit the conclusions drawn by Dr. P. E. Archinard, representative of the Louisiana State Board of Health. But this effect cannot be attributed to the action of sulphites. In the first place, it is a well-known fact that syrups and molasses are mild purgatives, and in the second place, Dr. Wiley[1] has found that "the increase in the amount of water in the feces due to the administration of sulphites, was not of sufficient magnitude to warrant classing the preservative as a purgative or cathartic."

No cases are on record where the slightest harm or injury was done to man or beast after a continued use of pure Louisiana syrups and molasses made by the sulphur process.

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[1] Bureau of Chemistry, Circular No. 37, 10.

METHODS FOR THE DETERMINATION OF FREE AND TOTAL SULPHUR DIOXIDE.

There is at present no method for directly determining the quantity of oxysulphonates in a certain material. It is necessary to determine the total sulphur dioxide after complete dissociation of the oxysulphonates. This gives the sum of sulphur dioxide itself, that in combination with mineral bases and that in the form of oxysulphonates. In another portion the "free sulphurous acid" is determined, that is sulphur dioxide itself, that present as mineral sulphites and that quantity of sulphur dioxide which is naturally present by a partial decomposition of the oxysulphonates. The difference of total and free sulphur dioxide represents the sulphur dioxide in the form of oxysulphonates.

I. TOTAL SULPHUR DIOXIDE.

The methods used at present for the determination of total sulphur dioxide in sugar products, may, according to the principles involxed, be divided into two groups, (1) methods necessitating a distillation, and (2) direct titration methods.

DISTILLATION METHODS.

The usual method of determining total sulphur dioxide in food products by distillation, may be outlined as follows: A suitable quantity of material is made up with water to a volume of at least 100 cc, and the sulphur dioxide is, after acidifying with phosphoric acid, distilled into standardized iodine solution, or into bromine water, passing a current of carbon dioxide through the distilling flask, to prevent oxidation. The amount of sulphur dioxide can then be found in the first case by titrating the excess of iodine with thiosulphate; in the second case by boiling off the excess of bromine and precipitating the sulphuric acid with barium chloride and weighing.

When we started our investigations on the sulphitation process at the Sugar Experiment Station, we did not know whether these two methods were directly applicable to sugar products or not, and an extensive study of methods for the determination of total sulphur dioxide was commenced. This work has not yet been completed, but the data collected so far are presented on the following pages, and will, after completion of the work, be published in full.

W. D. Horne[1] called attention to several sources of error in the provisional official method for the determination of sulphurous acid in foodstuffs when this method is applied to sugar products. Recently Edward Gudeman published a paper on the same subject.[2]

The following questions had to be studied: I. Whether molasses contains any hydrogene sulphide or gives rise to it when boiled in the presence of free acid, and whether hydrogen sulphide and sulphurous acid can be given off simultaneously without acting upon each other. II. Whether there is any error due to outside sources (use of gas for heating, rubber for connections, tin for condensers). III. Whether any volatile substances are given off during the distillation which are apt to be acted upon by iodine; and whether or not iodine is lost by volatilization. IV. Whether the use of a current of carbon dioxide is necessary. V. Whether the total amount of sulphurous acid distills over with the first half of the distillate.

According to our present knowledge of the composition of the sugar cane and its products, most, if not all, of the organic sulphur is in the form of proteid sulphur. By boiling in an acid solution the proteids are decomposed and so far the following cleavage products containing sulphur have been isolated: Cystin, cystein, alpha and beta thio—lactic acid, thio glycollic acid, ethylsulphide, methylmercaptan, and hydrogen sulphide. The thio acids mentioned above decompose further upon prolonged heating, yielding hydrogen sulphide. The presence of hydrogen sulphide in the distillation products of molasses is therefore to be expected. This was suggested by Dr. Horne[3] and also by Jerome Alexander[4] in a paper on the determination of sulphurous acid in gelatine. The following experiments were performed to decide this question: Fresh cane juice was boiled down to syrup without the use of any chemicals; 100 g of this was diluted to 400 cc, 5 cc of 85% phosphoric acid added and distilled. The distillate was collected in a flask containing de Koninck's reagent for hydrogen sulphide (mercuric cyanide and ammonium chloride in water). A black precipitate was obtained which after filtration was dissolved in bromine water. The solution gave a precipitate of barium sulphate when tested with barium chloride. Experiments carried out in a similar manner with silver nitrate and lead acetate solutions gave the same results. After receiving a copy of Dr. Horne's paper, cadmium chloride was used and our observations could be confirmed. The filtrate from the cadmium sulphide was also tested for sulphur, with positive results. This volatile sulphur which is not in the form of hydrogen sulphide may be due to the volatilization of substances of a mercaptan like character. We have not been able so far, on account of the small quantities obtained, to identify them or to prevent their determination together with sulphurous acid.

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[1] Proceedings 23 Annual Convention, A. O. A. C., 1906, 125.

[2] Proceedings 37th General Meeting Amer. Chem. Soc., 1907.

[3] l. c.

[4] Jour. Amer. Chem. Soc., 29, 783.

Similar experiments were performed with a molasses ensuing from the sulphitation process as practiced in Louisiana. Hydrogen sulphide was again obtained which proves that under the conditions of procedure sulphurous acid and hydrogen sulphide may coexist. It is, therefore, advisable to use a solution of cadmium-chloride in the determination, as recommended by Horne.

Gas can, without any risk, be used for heating the distilling flask. But if it be found necessary to concentrate the distillate, this should be done in flasks with narrow openings. Rubber connections should be avoided as much as possible, especially at this side of the condenser which is connected with the receiver containing iodine or bromine. It was found that the use of rubber may introduce considerable error. Where two glass tubes are to be connected with rubber hose the two ends of the glas tubes should touch. In a number of distillations a Kjeldahl condenser with tin serpentines was used and in this case a slight deposit of sulphur was invariably noticed in the glass tube extending into the receiver. When glass condensers were substituted for those of tin, that deposit could not be observed. The deposit is probably due to the interaction of hydrogen sulphide and sulphur dioxide, but the tin seems to play some part in this reaction.

Dr. Horne called attention to the possibility that sugar products like molasses, when distilled in acid solution, might give off volatile organic substances which are acted upon by iodine. In order to test this question, we secured a sample of molasses from a house where no sulphur is used. In one experiment the distillate was collected in bromine water after washing with cadmium-chloride solution, and the sulphur determined gravimetrically in the cadmium-sulphide as well as in the filtrate from it, combined with the bromine water. In a second determination the official method was used, the dilution in the distilling flask and the quantity of liquid distilled over being the same as in the first experiment. It was found that the official method yielded considerably more "sulphur" than was obtained by the gravimetric determination. However, this discrepancy is partly due to the fact that in spite of the U tube provided for in the official method, some iodine volatilizes during the distillation. This could easily be shown by connecting the U tube with a glass tube extending into a small flask which contained a solution of potassium iodide. When the distillation was finished, the potassium iodide had taken up a considerable quantity of iodine, however, not enough to make up for the difference from the gravimetric method.

Several experiments carried out with and without the use of a current of carbon dioxide proved the advisability of using this precautionary measure, although the influence was not so great as we had anticipated. The inlet tube for the carbonic acid gas must extend into the liquid to prevent it from distilling back into this same tube.

After these preliminary experiments the following mode of procedure was adopted, avoiding the errors recognized so far: 50 g of molasses are transferred to a flask of sufficient capacity and made up to 400 cc with air-free water. The flask is closed with a rubber stopper (rubber can safely be used at this point) having three perforations. One of these is for the inlet tube for the carbon dioxide, the second for a small separatory funnel filled with phosphoric acid, the third for a catch-all connected by means of a good cork with a Liebig condenser. The other end of the condenser is connected with a glass tube leading into a filtering flask with a small quantity of a 2 per cent solution of cadmium-chloride. The glass tube must terminate below the surface of the liquid. After the filtering flask follows a U tube containing a little water and then a glass tube leading into bromine water in a little Erlenmeyer flask. The U tube prevents sucking back of the bromine water into the cadmium solution. After the receivers have been put in place, carbon dioxide is passed through the entire apparatus for about ten minutes. Then about 5 cc of phosphoric acid are added from the separatory funnel and 200 cc of the liquid distilled over. When the distillation is finished, the bromine water in the Erlenmeyer and the contents of the U tube are transferred to a beaker, and the cadmium solution containing the distillate is filtered into the bromine water. The excess of bromine is boiled off, and the sulphuric acid is precipitated as barium sulphate and weighed. If the hydrogen sulphide is to be determined also, the cadmium sulphide is dissolved in bromine water and the solution treated like the others.

We did not deem it advisable to distill to a smaller volume than 200 cc in order to avoid charring of the mass at certain points and subsequent reduction of sulphuric acid.

At last the influence of concentration was studied and very surprising results obtained. When the same quantity of molasses was diluted in one case to 600 cc and in the other to 400 cc and both were distilled down to 200 cc, the first experiment gave a much higher result than the second. This experience led us to investigate how much of the liquid must be distilled to obtain the entire quantity of SO_2. It was found that by adding again 200 cc of water after having distilled from 400 cc to 200 cc, new quantities of sulphurous acid were obtained, and it was necessary to repeat this procedure four times to practically distill over all the SO_2. In this case the last distillate contained only traces of sulphur. It was thus shown that by distilling over 800 cc the SO_2 could be satisfactorily determined. The method could be facilitated by mixing up 50 g of molasses to 1,000 cc and distilling down to 200 cc. In this case the receivers had naturally to be changed to some extent. Results agreed practically with those obtained by separate distillations.

After the true amount of SO_2 in a certain molasses had been determined in this way, the official method was tested for its accuracy. By distilling in the same way from 1,000 cc to 200 cc, 1/10 n iodine solution being used to collect the distillate and titrating with thio sulphate, results considerably higher than those by the above method were obtained.

The necessity of distilling off 800 cc of liquid renders the method very tedious, and it would be desirable to devise one which requires less time and labor.

Edward Gudeman[1] distills in a current of steam, thus keeping the volume of the liquid in the distilling flask constant, and titrates the sulphur dioxide in the distillate with iodine.

Another method has been proposed by Th. Schumacher and E. Feder.[2]

These authors distill into a measured quantity of standardized potassium iodate solution. The sulphur dioxide reduces a certain part of this to iodine. When the distillation is over, the iodine is boiled off, and the remainder of iodic acid determined by adding potassium iodide and sulphuric acid and titrating with sodium thio sulphate. The method eliminates two errors of the iodine titration method, the loss of iodine by volatilization and that due to substances distilling over which are acted upon by iodine. But that due to hydrogen sulphide is not avoided by this method. Still it may prove to be very valuable for commercial work.

DIRECT TITRATION.

Sulphur dioxide gas or that in mineral sulphites can easily be determined by acidifying the solution, adding starch indicator and titrating with standardized iodine. This method, however, is not directly applicable to products containing aldehydes or sugars. In this case a direct titration indicates only the "free" sulphur dioxide. In order to determine total sulphur dioxide, the oxysulphonates must first be broken up by treating with free alkali. If, after standing for some time, the solution is acidified and the titration made immediately, the quantity of total sulphur dioxide is obtained.

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[1] l. c.

[2] Ztschr. Unters. Nahrungs und Genussm., 10. 415, 649.

This method is very rapid, but there are some difficulties preventing its use for dark-colored final products of the sugar factory. These products contain substances other than sulphites, acting upon iodine. This can easily be shown by treating in the way indicated a syrup or molasses made without sulphur. In every case an iodine absorption is noticed and in one molasses this absorption was equivalent to 0.0768 per cent of sulphur dioxide, which would be far in excess of the limit set by Food Inspection Decision No. 76. Another trouble in using this method is due to the dark color of final products. They must be considerably diluted to be able to distinguish the blue coloration of the iodine starch.

The method is very handy for the determination of total sulphur dioxide in sulphured and clarified juices. We have shown by experiments that 100 cc of raw cane juice and juice clarified with lime alone do not absorb more than 0.2 cc of n/10 iodine. The iodine used, therefore, indicates the true amount of sulphur dioxide. Furthermore, the color of these products is light enough to render the determination of the endpoint easy and accurate.

II. FREE SULPHUR DIOXIDE.

Free sulphur dioxide is determined by simply ascertaining the iodine absorption of the material in the presence of acid, because free alkali would itself absorb iodine.

METHODS USED IN THE WORK ON THE SULPHITATION PROCESS.

The total sulphur dioxide was, in most cases, determined by the distillation method which is equally applicable to all products and therefore yields comparable results. It had to be simplified, on account of the large number of analyses made. Even though the results are not as accurate as they could be obtained with our best methods available, they are comparable, because the analyses were all made exactly alike. It was found that with material high in total sulphur dioxide, as is usually the case with freshly manufactured products, the error due to hydrogen sulphide and other sources is comparatively small.

A suitable quantity of the substance was diluted with water to 400 cc, phosphoric acid added and 200 cc distilled into bromine water. After finishing the distillation the excess of bromine was boiled off, and the sulphuric acid determined gravimetrically.

The results obtained by this method agreed very well with those obtained with the same products at the United States Pure Food Laboratory in New Orleans, where all precautions were used to ensure accurate results.

In the analyses of sulphured and clarified juices the direct titration method was often used. The results of this method are usually a little higher than those of the distillation method, but well within the limits of error. The following figures will demonstrate this:

	Distillation.	Titration.	Difference.
Sulphured juice	0.0185	0.0211	0.0026
Sulphured juice	0.0269	0.0286	0.0017
Sulphured juice	0.0223	0.0254	0.0031
Sulphured juice	0.0204	0.0214	0.0010
Sulphured juice	0.0242	0.0249	0.0007
Clarified juice	0.0133	0.0153	0.0020
Clarified juice	0.0166	0.0176	0.0010
Clarified juice	0.0224	0.0240	0.0016
Clarified juice	0.0173	0.0184	0.0011
Clarified juice	0.0291	0.0306	0.0013

The average difference for ten determinations is 0.0015. The titrations were made in the following way: 50 cc of juice were pipetted into a flask containing 25 cc of a n-solution of sodium hydroxide under constant shaking. After fifteen minutes the liquid was acidified with 10 cc of 35 per cent sulphuric acid, and a titration made immediately with n/10 iodine solution.

We are at present experimenting on a new rapid method for the determination of total sulphur dioxide and the results obtained so far are encouraging.

The determination of "free" sulphur dioxide was made in the same way as that of total sulphur dioxide by titration, substituting 25 cc of water for the sodium hydroxide solution. But this method can only be used with sulphured and clarified juices. Syrups and molasses must be considerably diluted, to be able to determine the endpoint of the titration, and dilution would cause the decomposition of oxysulphonates and an increase in free sulphurous acid. It was therefore necessary to determine the amount of free sulphur dioxide in syrups and molasses in some other way. We are at present experimenting on this point and the results obtained so far are laid down in the following chapter on page 33 and 47.

Quantity of Sulphur Dioxide in the Different Products of the Sugar House.

I. GENERAL CONSIDERATIONS.

A. SULPHUR DIOXIDE IN SULPHURED JUICE.

In conducting the sulphitation process the quantity of sulphur dioxide entering the raw juice is usually determined by the increase in the acidity of the juice. The first question to be studied was therefore, whether or not the acidity of the juice increases in the same ratio as the quantity of sulphur dioxide introduced. This again necessitated some preliminary experiments to find out if the sulphur dioxide while acting upon the juice undergoes any changes, and how much of the quantity used is actually found in the sulphured juice by analysis.

A solution of sulphur dioxide in water was prepared; 20 cc of this solution were on titration found to absorb 13.6 cc of n/10 iodine solution. A measured quantity of this sulphurous acid was then added to a measured quantity of raw cane juice and the total sulphur dioxide determined by titration. The results were as follows:

		cc n/10 Iodine.
50 cc juice	10 cc sulphurous acid	6.8
50 cc juice	20 cc sulphurous acid	13.65
50 cc juice	20 cc sulphurous acid	13.75
100 cc juice	20 cc sulphurous acid	13.6
100 cc juice	20 cc sulphurous acid	13.6
50 cc juice	40 cc sulphurous acid	27.2

The amount of sulphur dioxide found by analysis equals that added to the juice, and this shows that the bleaching effect of the sulphur dioxide on cane juice is apparently due to the formation of new compounds by addition, and not by reduction, because in the latter case a part of the sulphur dioxide would be converted into sulphuric acid and disappear.

After it had thus been established that a titration of total sulphur dioxide in the sulphured juice gives the true quantity added, determinations of total sulphur dioxide and of the acidity were made with the same juice sulphured to different acidities.

The natural acidity of the juice used was equal to 1.15 cc n/10 alkali per 10 cc of juice, employing phenolphthalein as indicator.

A solution of sulphur dioxide was prepared, containing 22 cc of normal sulphur dioxide per liter. Then measured quantities of juice and sulphurous acid were mixed and the acidity determined.

	Natural Acidity	Acid After Sulphuring	SO_2 Added	Increase of Acidity
10 cc juice 1 cc sulph. acid......	1.15	1.3	0.22	0.15
10 cc juice 1 cc sulph. acid......	1.15	1.3	0.22	0.15
10 cc juice 2 cc sulph. acid......	1.15	1.5	0.44	0.35
10 cc juice 2 cc sulph. acid......	1.15	1.6	0.44	0.45
10 cc juice 5 cc sulph. acid......	1.15	2.2	1.10	1.05
10 cc juice 5 cc sulph. acid......	1.15	2.25	1.10	1.10
10 cc juice 10 cc sulph. acid......	1.15	3.35	2.20	2.20
10 cc juice 10 cc sulph. acid......	1.15	3.4	2.20	2.25
10 cc juice 20 cc sulph. acid......	1.15	5.6	4.40	4.45
10 cc juice 50 cc sulph. acid......	1.15	12.3	11.00	11.15

The increase in acidity after addition of 1 cc and 2 cc of sulphurous acid, though well marked, is very small and the percentage error is rather large. For this reason, a second solution of sulphur dioxide was prepared with 170 cc of normal sulphur dioxide per liter, and 50 cc of juice taken. The following figures were obtained:

50 cc juice 1 cc SO_2................	5.75	7.2	1.70	1.45
50 cc juice 2 cc SO_2................	5.75	8.85	3.40	3.10

The results of these experiments show that the very first portion of the sulphur dioxide entering the juice causes an increase in the acidity of it, simply by liberating the organic acids from their combinations. The quantity of sulphur dioxide added to the raw juice can, therefore, be accurately ascertained by determining the increase of the acidity of the juice.

Cane juice dissolves a maximum of 9 per cent of sulphur dioxide (12.66 ounces per gallon of juice), but in practical sugar house work it is difficult to use more than 0.15 per cent (0.2146 ounce per gallon of juice). Or, in chemical terms, it is difficult to raise the acidity of cane juice, by passing sulphur dioxide into it, above about 6 cc of n/10 acid per 10 cc of juice. At the Sugar Experiment Station we usually sulphur to 5 cc, using about 0.11 per cent of sulphur dioxide on the weight of the juice. Most of the sugar houses of the State employ less than this quantity.

A part of the sulphur dioxide introduced into the juice combines with glucose and probably with other constituents of the juice. Since raw cane juice contains a large percentage of water, most of the sulphur dioxide is, on analysis, found to be in the free state.

The juices tested gave the following figures, in cc of n/10 iodine per 50 cc:

	1	2	3	4	5	6	7	8	9	10
Total SO_2	27.8	24.0	22.6	17.2	16.3	14.1	19.2	17.0	14.3	16.5
Free SO_2	27.3	22.8	21.0	15.7	15.3	13.6	18.6	16.2	13.7	15.7
$\frac{(T.S.-F.S.)\times 100}{T.S.}$	1.8	5.0	7.08	8.72	6.14	3.55	3.13	4.71	4.20	4.85

Average 4.92.

The fact that the sulphured juice contains some combined sulphur dioxide was further shown by making determinations of sulphur dioxide in different dilutions. The more we dilute the more free sulphur dioxide is formed by dissociation of the organic combinations.

cc of juice used.	cc of water used.	cc n/10 iodine found.
25	0	12.2
25	25	12.3
25	50	12.7
25	75	13.2
25	100	13.3
25	200	13.5
25	300	13.5

The sulphur dioxide in the sulphured juice does not oxidize as rapidly as is generally supposed. If a juice be kept for several weeks or months, it is found that the quantity of sulphurous acid goes down very little within the first twenty-four hours, no matter whether it is kept in an open vessel or in a glass-stoppered bottle. After the first day the sulphur content commences to fall perceptibly, and it decreases much more rapidly in the open than in the closed bottle. The quantity of combined sulphur dioxide remains practically constant until fermentation has set in and has reached a certain stage. When this happens the free sulphur dioxide falls down very rapidly to almost zero, and the total sulphur dioxide remains constant. Although no experiments have been made on this point, we know from the work of Ripper, Kerp and others, that sulphur dioxide occurs in fermented liquors in the form of acetaldehyde-oxysulphonic acid, which is a very stable compound, not subject to oxidation and only very little dissociated in aqueous solution. This explains the sudden decrease in free sulphurous acid and at the same time the constancy of the total sulphur dioxide. All these points can easily be seen from the diagrams on pages 35 and 36.

Two divisions in the axis of abscissas designate one day, and one on the axis of ordinates 0.2 cc of n/10 iodine solution. The uppermost curve shows the total sulphur dioxide of the sulphured juice, kept in a glass stoppered bottle, the second gives the free sulphur dioxide of the same juice, and the other two the total and free sulphur dioxide of the juice stored in an open bottle. These two curves run considerably lower on account of the oxidation taking place more rapidly. The curves for total and free sulphurous acid of the same juice are very nearly parallel, showing that it is only the free sulphur dioxide which suffers oxidation while the quantity of oxysulphonate remains perfectly constant. After 9-10 weeks the fermentation has proceeded to that stage when acetaldehyde is formed, and now the free sulphur dioxide drops down to nearly zero while the combined sulphur dioxide does not change any more.

The same results were obtained with two other sulphured juices, but these two instances may suffice.

B. SULPHUR DIOXIDE IN CLARIFIED JUICE.

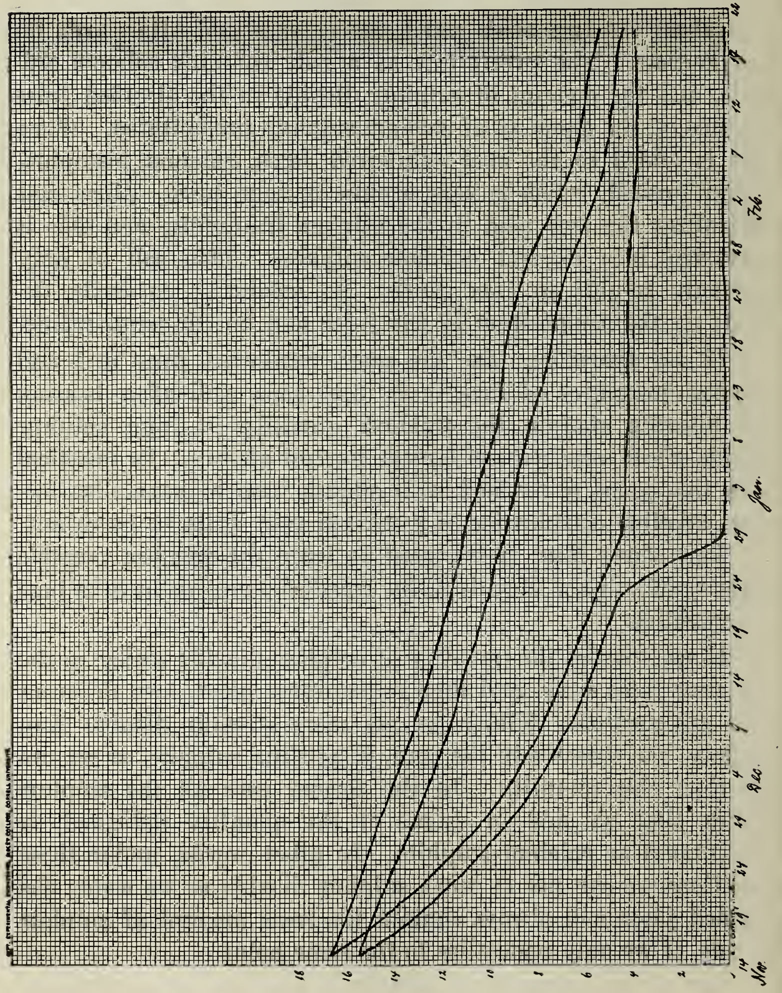
After the raw cane juice has been sulphured, it is sent to the clarifiers where lime is added to it. The effect of lime is twofold; it precipitates a large portion of the impurities and neutralizes the free acids which otherwise would afterwards invert sucrose. The precipitate as a rule contains calcium sulphite, and the amount of sulphur dioxide in the clarified juice depends on the quantity of calcium sulphite precipitated. When lime is added to the acid sulphured juice, calcium bisulphite is first formed, which is very soluble in cane juice. More lime neutralizes the free acid in the calcium bisulphite, and this is converted into neutral calcium sulphite. This salt is only sparingly soluble in cane juice. Its solubility naturally depends on the composition of the juice and on the temperature.

If we, therefore, take the same sulphured juice and add varying quantities of lime to it, that juice will after heating and filtering contain the smallest quantity of total sulphur dioxide which received the largest amount of lime. In practical cases this point is reached with adding lime to neutrality, because alkaline clarification is practiced very little in Louisiana.

This shows that, if we want to leave the smallest possible quantity of sulphur dioxide in the clarified juice, we have to lime to neutrality.

If we now let the quantity of sulphur dioxide added to the raw cane juice vary, and lime to the same point, two different cases are possible. Either we use more sulphur dioxide than the juice can dissolve in the form of calcium sulphite, or we use less than this quantity. In the former case all the sulphur dioxide that we add in excess of the quantity indicated, is precipitated as calcium sulphite. In other words, under these conditions we can use as much sulphur dioxide as we want; the clarified juice will always contain the same amount of sulphur dioxide, if we only neutralize to the same point.

But in the second case cited, conditions are quite different. If we add less sulphur dioxide to the raw cane juice than it can dissolve in the form of calcium sulphite, the addition of lime to the sulphured juice does not cause a precipitation of calcium sulphite, and now a further reduction of the sulphur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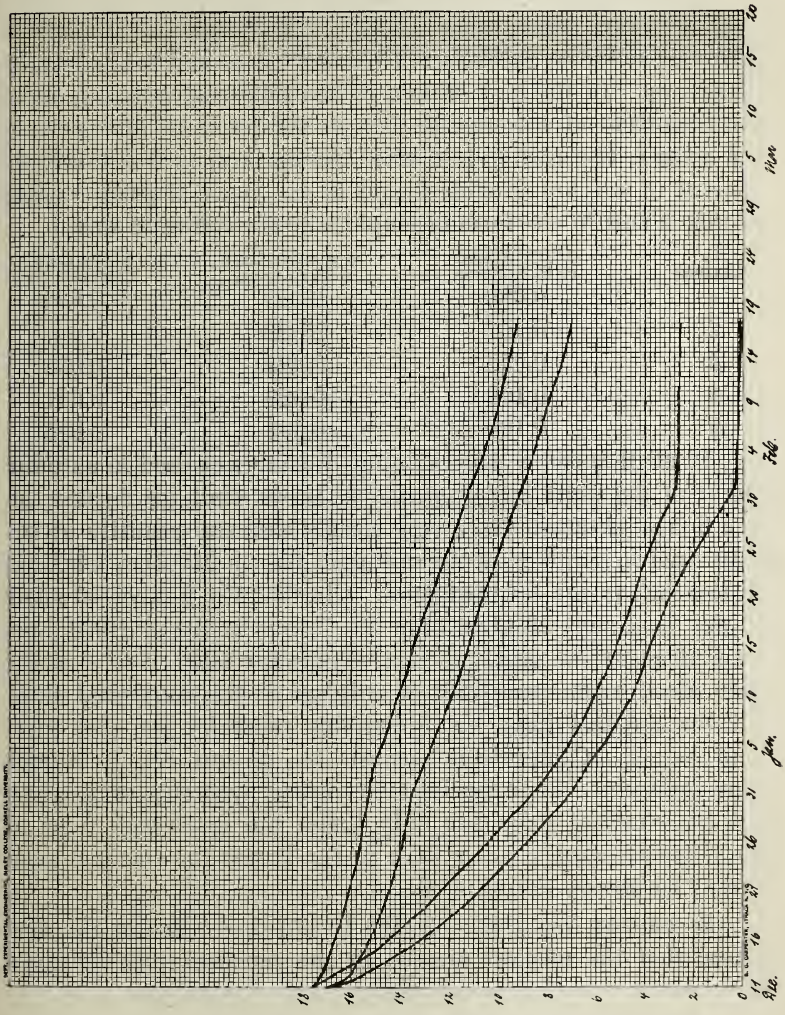
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dioxide employed in sulphuring the raw juice will be followed by a reduction in the clarified juice, even if we lime to neutrality.

Practical experiments conducted in the sugar house and laboratory proved the exactness of these theoretical conclusions.

In the sugar house runs the raw cane juice was treated with sulphur fumes, then limed in a 350-gallon clarifier to different acidities, heated until blanket broke and treated in the usual way. In the first column of the following table are given the quantities of sulphur dioxide on 100 parts of raw juice, in the second, the acidity left after liming, and in the third, the amount of sulphur dioxide found in the clarified juice. (Most of this is now in the form of sulphite or bisulphite of lime.)

No. Clarifier	% SO_2 Added to Raw Juice	% Acidity Left After Liming	% SO_2 Left in Clarified Juice
1	0.090	0.013	0.033
2	0.122	0.022	0.037
3	0.092	0.022	0.039
4	0.108	0.029	0.051
5	0.106	0.035	0.065

In all these runs more sulphur dioxide was used in sulphuring than the limit indicated above, as we shall see further on. The figures obtained show very clearly that the quantity of sulphur used in sulphuring the raw juice has no influence whatever on that left in the clarified juice. Clarifier No. 2 received about 30 per cent more sulphur than No. 3, but in the clarified juice we find about the same amount of sulphur left. Nos. 4 and 5 have about equal quantities of sulphur in the sulphured juice, but the clarified juice No. 5 contains about 28 per cent more than No. 4. Comparison between No. 2 and No. 5 is even more striking. No. 2 received the largest quantity of sulphur, but the clarified juice has only little; the sulphured juice of No. 5 is appreciably lower than in No. 2, but the clarified juice shows the largest figure of all.

If we now compare columns 2 and 3, we see at the first glance that the sulphur dioxide in the clarified juice increases in the same way as does the acidity of the limed juice.

No matter how much sulphur we use on the raw juice, we always find about the same quantity of sulphur dioxide in the clarified juice, if we only lime back to the same degree of acidity, and the nearer we approach the neutral point, the less sulphur dioxide will finally remain in the juice.

The laboratory experiments were carried out as follows:

Cane juice with 0.045 per cent natural acidity was treated with three different quantities of SO_2, 0.243 per cent, 0.147 per cent and 0.051 per cent. Each one of these three sulphured juices was then limed back to three different acidities, 0.064 per cent, 0.032 per cent and 0.000 per cent (neutrality). All nine juices obtained in this way were heated until blanket broke, filtered, and sulphur dioxide determined in the juice as well as in the precipitate.

The results of the experiment are seen from the following table: Column I gives the natural acidity of the juice, II the percentage of sulphur dioxide added, III the per cent acidity after liming, IV the sulphur dioxide in the clarified juice, and V that in the precipitate.

	Natural Acidity %	% SO_2 Added	Acidity After Liming	% SO_2 in Clarified Juice	% SO_2 in Precipitate
1	0.045	0.243	0.064	0.109	0.114
2	0.045	0.243	0.032	0.078	0.150
3	0.045	0.243	0.000	0.051	0.168
4	0.045	0.147	0.064	0.108	0.026
5	0.045	0.147	0.032	0.076	0.060
6	0.045	0.147	0.000	0.059	0.076
7	0.045	0.051	0.064	0.041	0.001
8	0.045	0.051	0.032	0.038	0.003
9	0.045	0.051	0.000	0.035	0.006

Experiments 1 to 6 confirm the results obtained in the sugar house. Whether we sulphur with 0.147 or with 0.243 per cent of sulphur dioxide, the sulphur dioxide in the clarified juice is the same, if we only lime back to the same acidity (0.109 and 0.108; 0.078 and 0.076; 0.051 and 0.059). The results also explain where the remainder of the sulphur goes. It is found in the precipitate. If we add up the SO_2 in the clarified juice to that in the precipitate we come very close to the total amount used in sulphitation; the rest has been lost by oxidation to sulphuric acid. The experiments furthermore confirm the results found before, that the clarified juice contains the more sulphur, the more acid we leave the juice after liming. The nearer we come to neutrality, the less sulphur we find in the clarified juice, and with neutrality itself we reach the minimum.

Therefore, if we want to leave a minimum quantity of sulphur dioxide in our products, we have to lime our juices to as near neutrality as possible.

The minimum quantity of sulphur that we can expect in the freshly treated clarified juice is, under these circumstances, about 0.055 per cent. If we use a quantity of sulphur which gives us just this amount of sulphur dioxide in the clarified juice, then practically no sulphur will be precipitated, even if we lime to neutrality. A glance at the table shows that the use of about 0.060-0.070 per cent of sulphur dioxide on raw juice will practically give this effect. In this case the point has been reached where the sulphur dioxide remains in solution as sulphite of lime. If we employ less than 0.060-0.070 per cent of sulphur dioxide, very nearly all of it will be found in the clarified juice, and the use of a smaller quantity of sulphur will necessarily be followed by a decrease in sulphur dioxide in the clarified juice and the after products. All these facts are clearly indicated in the results of experiments 7-9. Here only 0.051 per cent of sulphur dioxide was added to the juice. Consequently we find less sulphur in the clarified juice than where quantities above 0.060 per cent were used in sulphuring the juice. For reasons indicated above, it does not make much difference how much lime is used in neutralizing the acid. The precipitate contains very small quantities of sulphur dioxide which is due either to occlusion of sulphite of lime formed at a certain point, or to insufficient washing.

The diagram on page 42 shows all this more clearly than the table does. One division of the axis of ordinates is equivalent to 0.001 per cent of sulphur dioxide.

The results of these experiments clearly indicate the fact that the use of a smaller amount of sulphur than that usually employed by any one planter, is not necessarily followed by a decrease in the sulphur content of his after products. Only if we use so little sulphur that we keep within the limit of the solubility of sulphite of lime, a further reduction of the sulphur causes a reduction of it in the after products. This limit is reached with about 0.06-0.07 per cent of sulphur dioxide. But this quantity is itself so small that it will not aid sufficiently in the clarification of our cane juice, and a further reduction would not accomplish the purpose of clarification. Although it does not make much difference from a legal standpoint how much sulphur we use, if we go beyond a certain quantity, it does make a great deal of difference in the clarification. The more sulphur we use, the more impurities are removed and the greater is the decoloration obtained.

Determinations of oxysulphonates were again made in a number of clarified juices with the following results, expressed in cc of n/10 iodine per 100 cc of juice.

	1	2	3	4	5	6	7	8	9	10
Total SO_2	8.4	5.7	10.2	11.6	5.7	10.3	11.7	16.0	12.2	20.3
Free SO_2	4.3	2.8	4.6	8.6	2.00	6.9	8.8	12.9	8.9	17.9
$\frac{(T.\ S.-F.\ S.)\times100}{T.\ S.}$	48.81	50.88	54.90	25.86	64.91	33.01	24.79	19.37	27.05	11.82

Average 36.17.

The presence of glucose oxysulphonic acid was again demonstrated by making determinations of the sulphurous acid at different dilutions with the following results:

cc juice.	cc water.	cc n/10 iodine.
25	0	6.0
25	50	6.4
25	100	7.2
25	150	7.4
25	200	7.5
25	300	7.7
100	0	4.8
100	50	5.0
100	100	5.1
100	200	5.4
100	300	5.5

The quantity of oxysulphonic acid is considerably larger than in the sulphured juice. In this the average ratio of combined to total sulphur dioxide was found to be about 5:100 (see page 49); in the clarified juice this ratio is 36:100.

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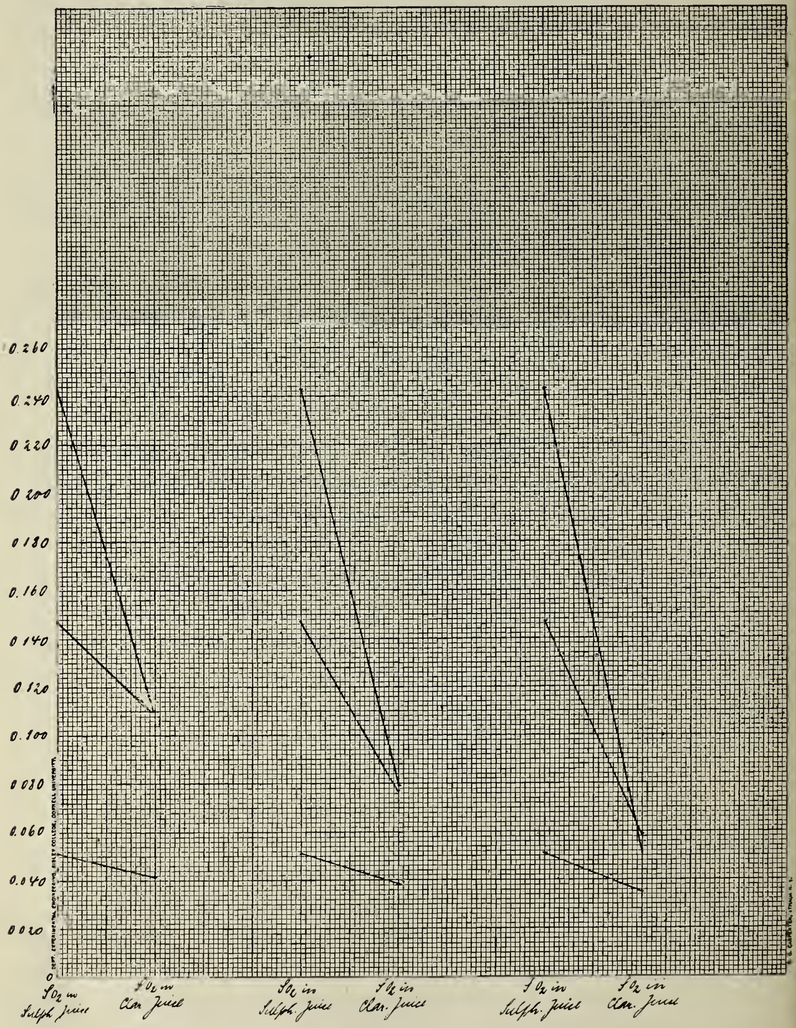
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SO2 in Sulph. Juice
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On comparing the quantities of combined sulphur dioxide in sulphured juice and in the clarified juice made from it, we find the following figures, in per cent:

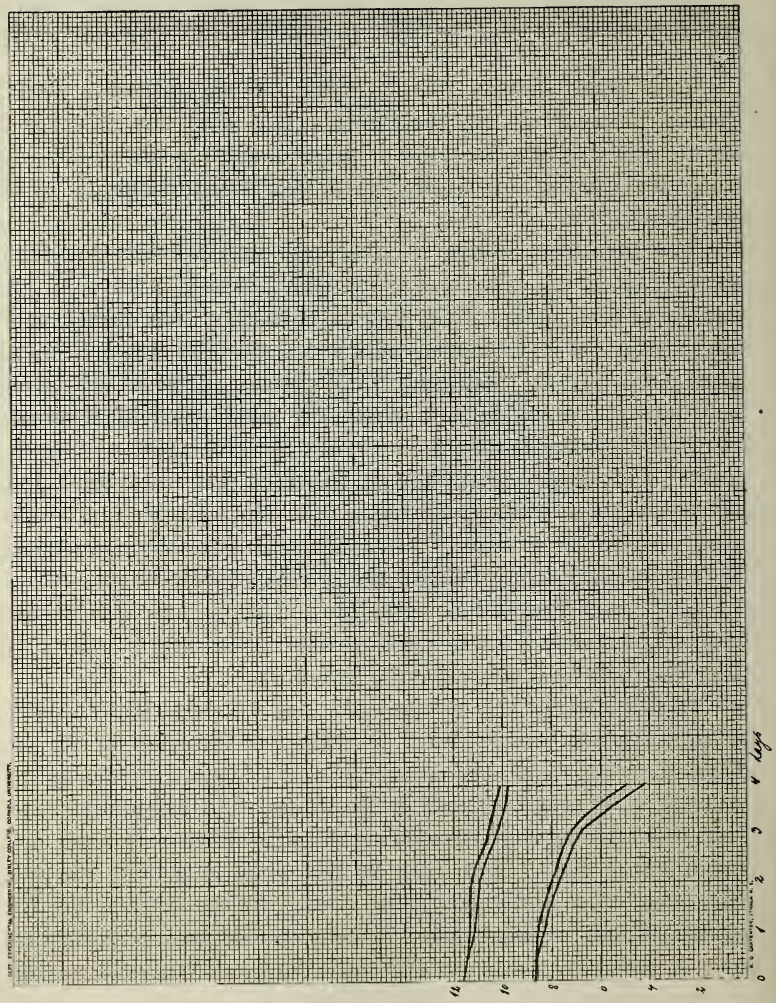
	1	2	3	4	5
Sulphured juice......	0.0060	0.0038	0.0048	0.0036	0.0048
Clarified juice	0.0100	0.0088	0.0096	0.0099	0.0126

This shows that a new quantity of oxysulphonic acid is actually formed during clarification and that the increase in the ratio of combined to total sulphur dioxide is not merely due to the precipitation or oxidation of free sulphur dioxide in the sulphured juice.

The rate of oxidation of total and free sulphur dioxide in clarified juice was also studied, in the same way as was done with sulphured juice. The general behavior was found to be very similar in both cases. However, clarified juice ferments much more quickly than sulphured juice. It takes only about four days for the former to reach the same stage of fermentation which, in the latter, does not set in until after nine to ten weeks. This is probably due to the fact that sulphured juice contains a large quantity of free acids, while clarified juice contains very little or none. After fermentation has commenced, the free sulphur dioxide drops down very rapidly to almost zero, owing to the formation of acetaldehyde-oxysulphonic acid, just as it is the case with sulphured juice. After this the total sulphur dioxide remains practically constant.

The two diagrams on pages 44 and 45 show the results of the experiments. In the first diagram ten divisions on the axis of abscissas are equal to one day, and one division on the axis of ordinates is equal to 0.2 cc of n/10 iodine. The uppermost curve gives the total sulphur dioxide in the juice kept in a glass stoppered bottle, the second that in the juice stored in an open container. The other two curves indicate the figures for free sulphur dioxide respectively. The curves for total and free sulphur dioxide again run parallel until fermentation sets in, when the free sulphur dioxide suddenly disappears. In the open bottle oxidation takes place more rapidly than in the stoppered bottle.

This experiment was, for lack of material, carried on for only four days. The second diagram shows the result of another


0
1
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days
12
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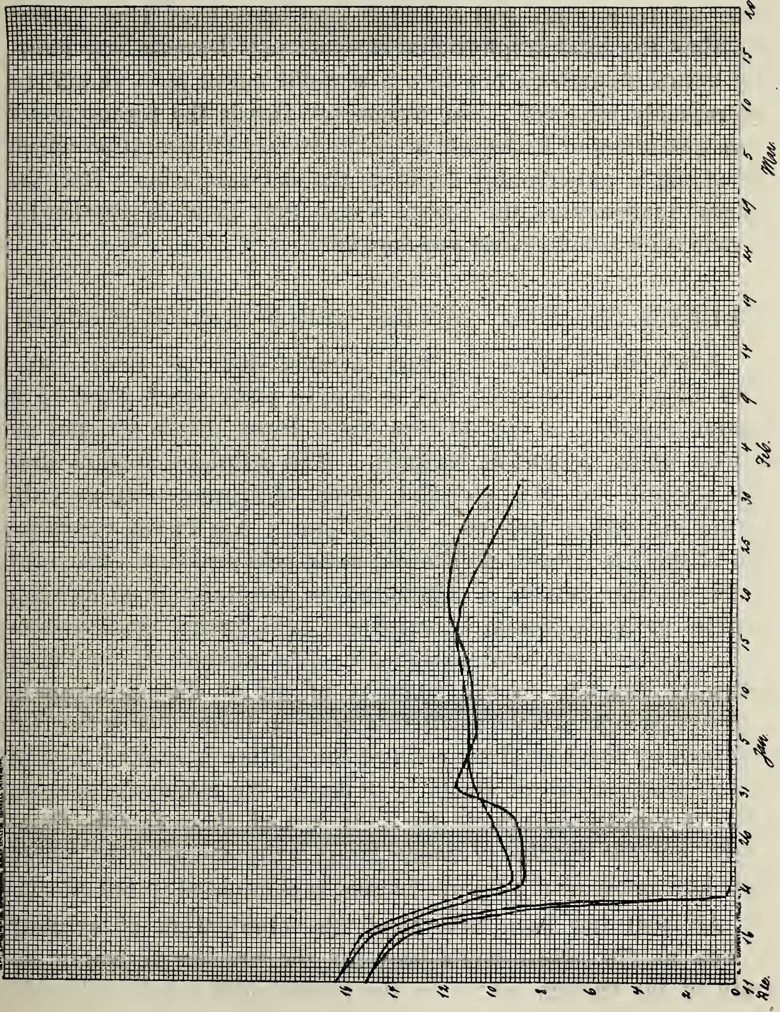
2
DEPT. EXPERIMENTAL ENGINEERING, SIBLEY COLLEGE, CORNELL UNIVERSITY.
R. D. CARPENTER, ITHACA, N. Y.


Dec.
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DEPT. EXPERIMENTAL ENGINEERING, SIBLEY COLLEGE, CORNELL UNIVERSITY.
E. G. CARPENTER, ITHACA N.Y.

experiment which covered a period of about seven weeks. In this case two divisions on the axis of abscissas designate one day. The general aspect of the curve is the same as we would expect from the first. The free sulphur dioxide decreases very rapidly after the fourth day and is almost zero after nine days. After this time the total sulphur dioxide does not decrease any more. The actual figures do not give a straight curve as it should be theoretically expected. The reason for this is the formation of large quantities of hydrogen sulphide during fermentation which introduces a considerable error in the determination. But the general tendency of the curves shows that there is practically no oxidation taking place any longer.

SULPHUR DIOXIDE IN THE SYRUP AND MOLASSES.

After clarification the juice usually does not receive any more chemical treatment, but is simply evaporated down to a greater density. In the modern sugar house this is effected by boiling under a partial vacuum. The sulphur dioxide that was present in the clarified juice, decreases considerably during the boiling process. This is partly due to the vaporization of sulphur dioxide on heating in an acid medium. But most of the sulphur dioxide is eliminated by precipitation of calcium sulphite or by oxidation to sulphuric acid, under the influence of the oxygen contained in the air. The amount of oxidation naturally depends on the quantity of air at disposal, and is therefore comparatively small in a vacuum house. It is further governed by the time during which the boiling is carried on and by the temperature at which it is done. No experiments were made to exactly determine the influence of these factors separately, but the results of sugar house runs compiled on pages show how much total sulphur dioxide is eliminated in the effects.

All that has been said about the elimination of sulphur dioxide in the effects holds true for the process of boiling to grain in the vacuum pan. In the centrifugals sulphur dioxide is removed from the molasses with the sugar, as is shown from the fact that sugars always contain an appreciable quantity of sulphur dioxide. This sulphur dioxide is removed from the molasses with each crop of sugar made. The actual quantities of total sulphur dioxide in the different grades of molasses will be found in the second part of this chapter.

It was attempted to determine free sulphur dioxide in the syrups and molasses from our sugars. But it was found to be impossible to do this with any degree of accuracy.

If we test a syrup or molasses, made without the use of sulphur at all, for free sulphur dioxide by the iodine method, we always apparently find appreciable quantities of it. Several samples of syrup tested 0.0032, 0.0045, 0.00704 and 0.0077 per cent, and one molasses as high as 0.0109 per cent. This shows that during the process of boiling substances are formed which reduce iodine, and the error which would, owing to this cause, be made in the determination of free sulphur dioxide in syrups or molasses is, in three cases out of five investigated, larger than the quantity of free sulphur dioxide permitted by Food Inspection Decision No. 76, and in the others too great to be neglected (about 50 per cent).

But this is not the only factor which renders the method very inaccurate. Syrups and molasses are in most cases so dark that they must be considerably diluted, to be able to distinguish the endpoint of the reaction. If this is done the oxysulphonic acid is split up into glucose and free sulphur dioxide, and consequently the results would always be too high.

In a few cases we succeeded in determining free and total sulphur dioxide in syrup from the effects of our sugar house, of a density of about 35 degrees Brix without dilution. Both determinations were made by titration with iodine and the error introduced in this case by other iodine absorbing substances being the same in both titrations, we could at least find the proportion of free to total sulphur dioxide with sufficient accuracy.

The four syrups analyzed gave these figures:

	1	2	3	4	
Total SO_2	6.5	16.0	16.8	20.3	
Free SO_2	1.4	4.9	5.8	6.6	
$\frac{(\text{T. S.}-\text{F. S.})\times 100}{\text{T. S.}}$	78.5	69.4	65.5	67.0	Average 70.1

In the sulphured juice we found 4.92 per cent of the total sulphur dioxide to be in the combined state, in the clarified juice 36.17 per cent. In a syrup of 35 degrees Brix this figure is as high as 70.1. So we may safely assume that in syrups of 70 degrees Brix and molasses of about 80 degree there will be only an exceedingly small percentage of free sulphurous acid left.

A method for the determination of free sulphur dioxide applicable to these products has not yet been found. It was, therefore, necessary to attack the problem in some other way. We are trying to solve it by preparing artificial mixtures containing in proper proportion all the ingredients of syrups and molasses which may have an influence on the ratio of free to total sulphur dioxide.

In some preliminary experiments the influence on this ratio of concentration, of the quantity of free organic acids and of the amount of total sulphur dioxide was studied.

Three solutions were prepared containing in a total of 200 g: 30, 60 and 90 g of dextrose respectively, and each 1 g of succinic acid and 5 cc of a solution of sodium bisulphite (2:100). The ratio of free to total sulphur dioxide was found to be 61:100 in the first, 36:100 in the second and 30:100 in the third. This shows that, other conditions being equal, the ratio of free to total sulphur dioxide decreases with an increase in the concentration of the dextrose. In other words, the more glucose a product contains the less free sulphur dioxide will be found in it, the quantity of total sulphur dioxide being equal in all cases.

In a second set of experiments the quantity of free organic acid was varied, dextrose and total sulphur dioxide being constant. Three solutions were again made, containing in 200 g 30 g each of dextrose and 5 cc of an eight per cent solution of sodium bisulphite, and 1, 2 and 3 grams of succinic acid respectively. In these experiments the ratio of free to total sulphur dioxide was found to be constant, and the percentage of free organic acid does not seem to play any important part, as long as the solutions are not heated.

The third series of experiments was carried out to determine the influence of the total sulphur dioxide, other conditions being constant. In each experiment 30 g of glucose and one gram of succinic were used and 1, 2, 4 and 6 cc of a solution of sodium bisulphite added. The total weight of each solution was again 200 g. The results are as follows:

	Total SO_2.	Free SO_2.	Ratio in per cent.
Solution with 1 cc sulphite solution....	3.3	2.0	60.6
Solution with 2 cc sulphite solution....	6.4	3.6	56.2
Solution with 4 cc sulphite solution....	12.5	6.1	48.8
Solution with 6 cc sulphite solution....	18.6	8.7	41.4

There is a slight tendency of the ratio to decrease with an increase in total dioxide. In other words: The higher the quantity of total sulphur dioxide, the lower is that of free sulphur dioxide in proportion to the total.

The studies on these points are being continued at the present time. We have taken up the influence of temperature, and have made some artificial mixtures which in their composition very nearly represent commercial syrups and molasses, but which do not contain that dark coloring matter of ordinary sugar house products.

We have been able to demonstrate that the glucose is not the only substance which has an effect on the percentage of combined sulphur dioxide, but that other constituents have a greater influence on it than glucose. The exact nature of these has not yet been determined, but it seems that they belong either to the proteids or pectinous bodies. When this has been ascertained, we shall make artificial syrups and molasses without coloring matter and test them for total and free sulphur dioxide.

From the figures given for the ratio of combined sulphur dioxide to total sulphur dioxide in sulphured juice (4.92 per cent), clarified juice (36.17 per cent), and syrup of 35 degrees Brix (70.1 per cent), and from what has just been said of this ratio for varying quantities of total sulphur dioxide, we may expect that our concentrated products will contain at least 80-90 per cent in the combined form.

The ratio of oxidation of the sulphur dioxide in commercial syrups and molasses is also being studied. In this case we could determine only the total sulphur dioxide. It diminishes very slowly, and it does not make much difference whether the products are stored in open containers or in cork stoppered bottles. Cork apparently is sufficiently porous to admit the small quantity of air necessary for the slow oxidation, and we may assume that the same is true for wooden barrels. However, the temperature seems to play an important part in this oxidation process. While it goes on only slowly in winter time, and in a cold room, it proceeds rather rapidly in the hot room and in summer time. The following figures will illustrate our findings:

MASSECUITE KEPT IN HOT ROOM.

	$SO_2\%$
On day of making	0.1296
After one week	0.0712
After two weeks	0.0654
After three weeks	0.0588
After four weeks	0.0496

MOLASSES KEPT IN LABORATORY STOREROOM.

Date.	I.	II	III.	IV.	V.	VI.
Nov. 23, 1906.	0.0322	0.1296	0.0946	0.0040	0.1132	......
Dec. 10, 1906.	......	......	......	......	......	0.0554
Dec. 22, 1906.	0.0240	0.1230	0.0814	0.0034	0.1028	......
Jan. 22, 1907.	0.0200	0.1198	0.0792	0.0044	0.0982	0.0548
April 29, 1907.	0.0034	0.0802	0.0488	......	......	0.0340
July 29, 1907.	......	0.0178	0.0114	......	......	0.0232

	VII		VIII	
Date.	Open.	Closed.	Open.	Closed.
Dec. 1, 1906	0.0794	0.0794	......	......
Dec. 10, 1906	......	......	0.0508	0.0508
Jan. 6, 1907	......	......	0.0490	0.0490
Jan. 22, 1907	0.0596	0.0572	0.0520	0.0532
April 29, 1907	0.0326	0.0336	0.0312	0.0310
July 29, 1907	......	0.0198	......	0.0264

II. SPECIAL CASES.

1. VACUUM HOUSES—RESULTS OF TEN EXPERIMENTAL RUNS.

A number of experimental runs were made in the sugar house during the seasons 1906-07 and 1907-08 with the object of finding out how much of the sulphur dioxide added to the raw juice is eliminated in one and the same run by the different operations carried on in the process of manufacture.

In six of these runs the juice was sulphured until its acidity, determined in 10 cc of juice, was equivalent to 5 cc decinormal solution. The average quantity of sulphur dioxide thus passed into the raw juice, was 0.1091 per cent. In five out of these runs the acidity was brought back with lime to 0.2 cc decinormal, that is, to nearly neutrality; in the sixth less lime was employed, and the acidity of the limed juice left at 0.8 cc decinormal.

In one run we sulphured with only 0.0488 per cent of sulphur dioxide, and in another (VIII) with still less, 0.0382 per cent.

Two further runs (IX and X) were made with lime alone, using no sulphur at all.

Total sulphur dioxide as well as total sulphur was determined in the products of the different runs. By total sulphur is meant the sum of all sulphur containing substances like sulphates, proteid bodies and certain amido acids, all expressed as elementary sulphur.

All figures for total sulphur dioxide are also expressed as elementary sulphur to be comparable with those for total sulphur.

The determinations of total sulphur dioxide were made by the method described on page 29.

Total sulphur was, in the products of the first run, determined after incineration. However, this method was found to be inaccurate, because a part of the organic sulphur volatilizes during the incineration, and some of the sulphate is invariably reduced to sulphide, by the action of the carbon. For this reason all of the other sulphur determinations were made in the following way. A suitable amount of the product was heated with nitric acid in a Kjeldahl flask, after the addition of some potassium nitrate. When the liquid was evaporated to about 20 cc, a new portion of nitric acid was added, and this process repeated, until no more red fumes were given off. As a rule three digestions were found to be sufficient. The contents of the flask were then poured into a porcelain dish, evaporated to dryness on a water bath, and the dry residue heated over a naked flame, until it was completely ashed. The resulting ash was then treated with hydrochloric acid on a water bath and the silica rendered insoluble by baking at 130 degrees. The sulphuric acid was then determined in the usual way. Some of the organic sulphur may escape oxidation in this method, but the results obtained by it are at least comparable.

The results of our experiments are found in the tables, page 53 to page 55. The first column gives the name of the different products, the second their respective weights, column three the actual percentage of total sulphur, column four the same calculated for equal concentrations. In the next column the quantity of total sulphur in raw juice is called 100, and the other figures in this column give the quantities of total sulphur for equal concentration on the basis of 100. Column six contains the percentages of total sulphur dioxide, column seven the same for equal concentrations, and eight the same calculated on the basis of 100 in sulphured juice. The following column nine gives the ratio of total sulphur dioxide to total sulphur in a certain product, multiplied by 100.

The six tables on page 53 to page 55 give the results of one to six, where the juice was sulphured to 5 cc acidity, and then limed to 0.2 in run 1-5, and to 0.8 in run 6.

RUN I.

PRODUCT.	Weight, pounds.	Total sulphur (S) %.	Same for equal concentration.	Same on basis of 100.	Sulphur as sulphur dioxide (S) %.	Same for equal concentration.	Same on basis of 100.	Relation of S as SO_2 to total S.
Mill juice	28639	0.04000	0.04000	100.00	......	......	......	......
Sulphured juice		0.07095	0.07095	177.37	0.05154	0.05154	100.00	72.64
Clarified juice		0.04573	0.04573	114.32	0.01492	0.01492	28.94	32.60
I. massecuite	4013	0.3836	0.05963	149.07	0.0540	0.00757	14.67	14.08
I. molasses	3405	0.4734	0.05628	140.70	0.0397	0.00472	9.16	8.39

RUN II.

PRODUCT.	Weight, pounds.	Total sulphur (S) %.	Same for equal concentration.	Same on basis of 100.	Sulphur as sulphur dioxide (S) %.	Same for equal concentration.	Same on basis of 100.	Relation of S as SO_2 to total S.
Mill juice	17302	0.0361	0.0361	100.00	......	......	......	......
Sulphured juice		0.0986	0.0986	273.13	0.05743	0.05743	100.00	58.22
Clarified juice		0.0525	0.0525	145.43	......	......	......	......
Syrup	4605	0.1878	0.04998	138.45	0.0372	0.00990	17.24	19.81
I. massecuite	2051	0.3995	0.04736	131.19	0.0526	0.00623	10.86	13.17
I. molasses	1663	0.3675	0.03532	97.84	0.0524	0.00504	8.77	14.26
II. massecuite	1190	0.6105	0.04199	116.32	0.0648	0.00446	7.76	10.61
II molasses	794	0.7030	0.03226	89.36	0.0277	0.00127	2.21	3.94
III. massecuite	732	0.7527	0.03184	92.63	0.0256	0.00108	1.89	3.40

RUN III.

PRODUCT.	Weight, pounds.	Total sulphur (S) %.	Same for equal concentration.	Same on basis of 100.	Sulphur as sulphur dioxide (S) %.	Same for equal concentration.	Same on basis of 100.	Relation of S as SO_2 to total S.
Mill juice	16394	0.0449	0.0449	100.00	....	....	....	....
Sulphured juice		0.1198	0.1198	266.81	0.06528	0.06528	100.00	54.42
Clarified juice		0.0802	0.0802	178.62	0.02147	0.02147	32.90	26.81
Syrup	3023	0.3225	0.05947	132.45	0.0606	0.01117	17.12	18.79
I. massecuite	2438	0.3800	0.05651	125.86	0.0451	0.00671	10.27	11.87
I. molasses	925	0.7596	0.05250	116.93	0.0778	0.00538	8.24	10.24

RUN IV.

PRODUCT.	Weight, pounds.	Total sulphur (S) %.	Same for equal concentration.	Same on basis of 100.	Sulphur as sulphur dioxide (S) %.	Same for equal concentration.	Same on basis of 100.	Relation of S as SO_2 to total S.
Mill juice	12455	0.0595	0.0595	100.00	....	....	....	....
Sulphured juice		0.1107	0.1107	186.05	0.05098	0.05098	100.00	46.05
Clarified juice		0.0771	0.0771	129.58	0.01500	0.01500	29.42	19.46
Syrup	4117	0.2449	0.08095	136.05	0.03093	0.01022	20.05	12.63
I. massecuite	2071	0.4532	0 07536	126.65	0.03359	0.00559	10.96	7.41
II. massecuite	764	0.8037	0.04930	82.86	0.06238	0.00383	7.51	7.76
II. molasses	503	0.6074	0.02453	41.23	0.03403	0.00137	2.69	5.60

RUN V.

PRODUCT.	Weight, pounds.	Total sulphur (S) %.	Same for equal concentration.	Same on basis of 100.	Sulphur as sulphur dioxide (S) %.	Same for equal concentration.	Same on basis of 100.	Ratio of S as SO_2 to total S.
Mill juice	13.74 Brix	0.06187	0.06187	100.00	......	......	......	......
Sulphured juice		0.10820	0.10820	174.88	0.04752	0.04752	100.00	43.92
Clarified juice		0.08436	0.08436	136.35	0.01801	0.01801	37.90	21.35
Syrup	34.70 Brix	0.2082	0.08244	133.25	0.02152	0.00852	17.93	10.34

RUN VI.

PRODUCT.	Weight, pounds.	Total sulphur (S) %.	Same for equal concentration.	Same on basis of 100.	Sulphur as sulphur dioxide (S) %.	Same for equal concentration.	Same on basis of 100.	Ratio of S as SO_2 to total S.
Mill juice	10517	0.05208	0.05208	100.00	......	......	......	......
Sulphured juice		0.10258	0.10258	196.96	0.04490	0.04490	100.00	43.77
Clarified juice		0.08187	0.08187	157.20	0.01970	0.01970	43.87	24.06
I. massecuite	1808	0.4285	0.07366	141.45	0.06252	0.01075	23.94	14.59
II. massecuite	978	0.7309	0.06797	130.51	0.05965	0.00554	12.34	8.16
II. molasses	647	0.7856	0.04833	92.83	0 05848	0.00360	8.01	7.44

The tables show that the absolute percentage of sulphur dioxide in our final products is of about the same order as that in the sulphured juice, sometimes higher, sometimes lower. It is very important to note that the quantity of sulphur dioxide in the first and second molasses manufactured by our best and most effective process is in each and every case higher than Food Inspection Decision No. 76 permits. We find 0.0794, 0.1048 and 0.1556 per cent SO_2 in first molasses, and 0.0554, 0.0681 and 0.1169 per cent SO_2 in second molasses.

The absolute figures for sulphur dioxide in the different products do not give us any direct information about the quantity of sulphur dioxide eliminated by the operations of the manufacturing process. It is necessary to reduce them to a uniform basis in order to make them comparable. If we take this into consideration and calculate the amount of sulphur dioxide for equal concentrations, calling the absolute quantity in the sulphured juice 100, we find the actual rate at which the sulphur dioxide is gradually eliminated or reduced. By comparing the values found in this way for the first five runs which were made in the same way, we observe a very close agreement between the figures of the different runs. This can be easily seen from the following table containing the figures of column 8 of the five runs:

No. of Run	Sulph. Juice	Clarified Juice	Syrup	I. Massecuite	I. Molasses	II. Massecuite	II. Molasses.
1	100	28.94	.....	14.67	9.16	....	....
2	100	.....	17.24	10.86	8.77	7.16	2.21
3	100	32.90	17.12	10.27	8.24	....	....
4	100	29.42	20.05	10.96	....	7.51	2.69
5	100	37.90	17.93	.....	....	....	....
Av.	100	32.29	18.08	11.69	8.72	7.63	2.45

This table shows how quickly the sulphur dioxide is reduced during the manufacturing process, so that the first molasses contains only 8.72 per cent and the second only 2.45 per cent of that originally added to the raw juice.

The considerations leading us to the calculation of sulphur dioxide for equal concentration also hold true in the case of the total sulphur. The table below gives the figures calculated accordingly for total sulphur, in the same five runs, calling that in the raw juice 100.

No. of Run	Raw Juice	Sulph. Juice	Clarified Juice	Syrup	I. Massecuite	I. Molasses	II. Massecuite	II. Molasses
1	100	177.37	114.32	149.07	....	140.70	....	....
2	100	273.13	145.43	138.45	131.19	97.84	116.32	89.36
3	100	266.81	178.62	132.45	125.86	116.93	....	....
4	100	186.05	129.58	136.65	126.65	....	82.86	41.33
5	100	174.88	136.35	133.25	....	....	....	....
Av......	100	215.65	140.86	137.85	127.90	118.49	99.59	65.30

The equivalent quantity of total sulphur in the first molasses is not very much higher than that contained in the raw cane juice in its natural state, and that in the second molasses is considerably lower.

The sulphur dioxide diminishes more rapidly than the total sulphur. This is probably due to the precipitation of calcium sulphite as such during evaporation. The following table gives the ratio of sulphur dioxide to total sulphur in the five runs, illustrating these conditions:

No. of Run	Sulph. Juice	Clarified Juice	Syrup	I. Massecuite	I. Molasses	II. Massecuite	II. Molasses
1	72.64	32.60	.....	14.08	8.39	.....	....
2	58.22	.....	19.81	13.17	14.26	10.61	3.94
3	54.42	26.81	18.79	11.87	10.24	.....	....
4	46.05	19.46	12.63	7.41	.....	7.76	5.60
5	43.92	21.35	10.34	.....	.....	.....	....
Av.	55.05	25.05	15.39	11.63	10.96	9.18	4.77

SUGARS.

Three first and two second sugars were analyzed for total sulphur and sulphur dioxide, and we found these figures:

	Total Sulphur S	Sulphur Dioxide SO_2
I. Sugar	......	0.0120
I. Sugar	0.2258	0.0218
I. Sugar	0.2264	0.0230
II. Sugar	0.5395	0.0176
II. Sugar	0.4267	0.0390

Only one second sugar contained more than 0.035 per cent of sulphur dioxide. But these sugars are usually not consumed as such and there need not be any apprehension about the high quantity of sulphur dioxide in them.

RUN VI. RAW JUICE SULPHURED TO 5 CC ACIDITY, LIMED TO 0.8 CC ACIDITY.

This run very clearly shows the effect of the use of a smaller quantity of lime in clarification than is required to neutralize the acidity of the sulphured juice. It has been shown on page 38 that in this case the clarified juice contains a larger amount of sulphur dioxide than under normal conditions. This high percentage of sulphur dioxide in the clarified juice is naturally followed by a higher quantity of this substance in the other products of such a run, as will be seen from the following table, which requires no further comment:

TOTAL SULPHUR DIOXIDE.

	Sulp Juice	Clarified Juice	Syrup	I Massecuite	I. Molasses	II. Massecuite	II. Molasses
Runs 1-5	100	32.29	18.08	11.69	8.72	7.63	2.45
Run 6.........	100	43.87	.....	23.94	....	12.34	8.01

RUNS VII AND VIII. SMALLER QUANTITIES OF SULPHUR USED IN SULPHURING THE JUICE THAN IN RUNS 1-6, AND LIMED BACK TO 0.2 ACIDITY.

These runs were conducted to find out whether the use of a smaller quantity of sulphur in sulphitation is followed by a reduction of sulphur dioxide in the after products. This point has been thoroughly studied, as far as clarification is concerned, and we have seen (page 38) that, if the sulphur dioxide added to the raw juice be limited, the clarified juice does not necessarily contain less sulphur dioxide. It was found that this takes place only when less than 0.06-0.07 per cent of sulphur dioxide is employed, and it was remarked there that this figure must vary somewhat with the composition of the juice.

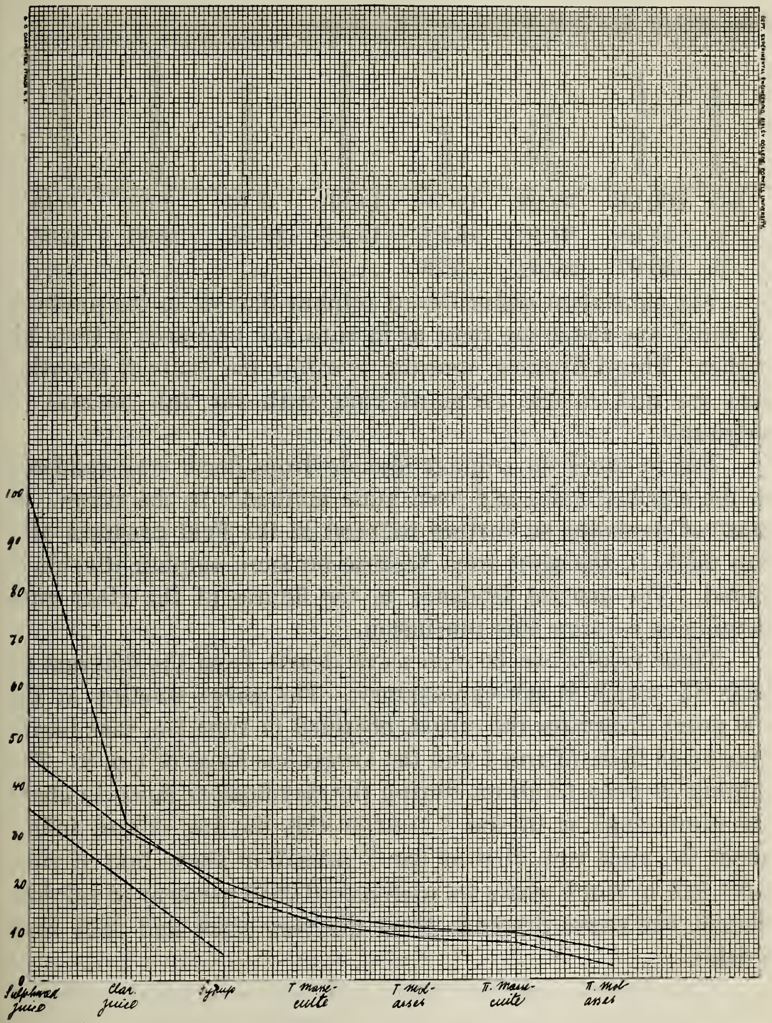
Runs VII and VIII have confirmed those results, and have further shown that even with the use of only 0.049 per cent the indicated limit may be exceeded. This latter quantity of sulphur dioxide was employed in Run VII. In the next run the sulphur dioxide was reduced to 0.038 per cent. The results are seen from the two following tables which are arranged in the same way as those for runs 1-6. Unfortunately run 8 could not be finished because the vacuum pan which we intended to use for this work was out of order and could not be repaired quickly enough.

RUN VII.

PRODUCT.	Weight, pounds.	Total sulphur (S) %.	Same for equal concentration.	Same on basis of 100.	Sulphur as sulphur dioxide (S) %.	Same for equal concentration.	Same on basis of 100.	Ratio of S as SO_2 to total sulphur.
Mill juice	12420	0.05045	0.05045	100.00				
Sulphured juice		0.07852	0.07852	155.64	0.02439	0.02439	100.00	31.06
Clarified juice		0.07004	0.07004	138.84	0.01629	0.01629	66.79	23.26
Syrup	4084	0.2171	0.07140	141.53	0.03233	0.01063	43.59	14.88
I. massecuite	2059	0.3758	0.06230	123.49	0.04183	0.00694	28.43	11.13
I. molasses	1057	0.6533	0.05560	110.20	0.06761	0.00568	23.28	10.35
II. massecuite	773	0.8608	0.05357	106.20	0.08420	0.00524	21.49	9.78
II. molasses	556	0.5991	0.02682	53.16	0.06927	0.00310	12.71	11.56

RUN VIII.

PRODUCT.	Weight, pounds.	Total sulphur (S) %.	Same for equal concentration.	Same on basis of 100.	Sulphur as sulphur dioxide (S) %.	Same for equal concentration.	Same on basis of 100.	Ratio of S as SO_2 to total sulphur.
Mill juice	13.67 Brix	0.06187	0.06167	100.00				
Sulphured juice		0.08515	0.08515	137.63	0.01909	0.01909	100.00	22.42
Clarified juice		0.07941	0.07941	128.35	0.01086	0.01086	56.89	13.67
Syrup	34.90 Brix	0.1806	0.07074	114.34	0.00852	0.00334	17.48	4.72


100
90
80
70
60
50
40
30
20
10
0
Sulphured juice
Clar. juice
Syrup
I masse-cuite
I mol-asses
II. masse-cuite
II. mol-asses

For a better comparison of the results the table below was compiled which is based on the figures in column 8 of the two tables on page 60 and the corresponding ones in runs 1-5. The quantity of sulphur dioxide used in runs 1-5 is called 100, and all the values are calculated on this basis.

No. of Run	Sulph. Juice	Clarified Juice	Syrup	I. Massecuite	I. Molasses	II. Massecuite	II. Molasses
1-5	100.00	32.29	18.08	11.69	8.72	7.63	2.45
7	46.08	30.78	20.09	13.10	10.73	9.90	5.86
8	36.07	20.52	6.29	.....	.....	.....	.....

The equivalent quantities of sulphur dioxide in the products of run 7 are about the same as in runs 1-5, and even a little bit higher. This difference, however, is within the limits of variation that we find in the series of runs with the full amount of sulphur.

But in run 8 the sulphur dioxide drops down very suddenly in the clarified juice and even more markedly in the syrup. It must of necessity be further reduced in the final products of a run made in the same way, because no more sulphur dioxide is added. The general tendency in the figures of the other runs permits us to draw this conclusion.

These results can be seen more clearly from the diagram on page 61, which is self-explanatory. The curve starting at the 100 point illustrates the results obtained in runs 1-5, that beginning at 46 those of run 7 and the lowest one those of run 8. The sulphur in runs 1-5 drops during the clarification down to about the same point as in run 7. After this the two curves follow about the same way, that of run 7 ascending above that of runs 1-5. But in run 8 where we used only 0.0382 per cent of sulphur dioxide the curve descends from the very start and falls very quickly.

This shows conclusively that only a very material reduction in the quantity of sulphur used in sulphitation results in a reduction of sulphur dioxide in the after products.

The quantities of total sulphur for equal concentration are very nearly constant in all runs, at least do not vary long enough to be of any consequence.

For this reason the ratio of sulphur dioxide to total sulphur is about the same in runs 1-5 and 7, but decreases very markedly in run 8, as will be seen from the following table:

No. of Run	Sulph. Juice	Clarified Juice	Syrup	I. Massecuite	I. Molasses	II. Massecuite	II. Molasses
1-5	55.05	25.05	15.39	11.63	10.96	9.18	4.77
7	31.06	23.26	14.88	11.13	10.35	9.78	11.56
8	22.42	13.67	4.72	.....	.....	....	.....

The absolute quantity of sulphur dioxide in the first and second molasses of run 7 is appreciably higher than in runs 1-5, and this is due to the fact that it is a little higher in the clarified juice and is therefore proportionately higher in the final products.

SUGARS.

The two sugars made in run 7 were tested for total sulphur and sulphur dioxide. The first sugar contained 0.0843 and 0.0148 per cent, and the second 0.4862 and 0.0372 per cent respectively, about the same as we found in sugars made with the full amount of sulphur, except total sulphur in the first sugar.

RUNS 9 AND 10, ONLY LIME USED IN CLARIFICATION.

In the products of these runs only total sulphur was to be determined. The results are given in the table below:

	RUN 9			RUN 10		
Product	% Total Sulph.	Same for Equal Conc.	Same on Basis of 100	% Total Sulph.	Same for Equal Conc.	Same on Basis of 100
Raw juice	0.04355	0.04355	100.00	0.06187	0.06187	100.00
Clar. juice	0.04270	0.04270	98.05	0.05812	0.05812	93.94
Syrup ...	0.1428	0.04657	106.93	0.1842	0.5877	94.99
I. M. C....	0.2666	0.04399	101.01	....	....	......
I. Mol.....	0.2137	0.01638	37.61	....	....	......

The results show that lime removes only very little total sulphur in clarification. The syrup, according to the analyses, has more total sulphur than an equivalent quantity of the clarified juice. This is most probably due to the fact that the juice, being low in sulphates, dissolved some of the scale in the effects, aided by mechanical action during boiling. The same phenomenon was observed in runs 1 and 4. In one of these the total sulphur in the clarified juice was also low. But the absolute amount of total sulphur in the syrup is naturally lower than in those runs where sulphur was used in clarification and this difference becomes still more marked in the final products. The percentage of total sulphur in the only sugar made, first sugar in run 9, is also lower than in the first sugars made by the sulphitation process (0.0659 per cent).

The yields as obtained by the different processes were also determined, but they are not comparable. We did not use the same kind of cane for all of the runs and the yields depend on so many other circumstances that no conclusions could be drawn from the figures. However, all this was no more necessary, after Dr. Stubbs and his collaborators had very thoroughly studied the different methods of clarification from exactly this standpoint for a number of years. We did know, as has been shown in the introduction to this bulletin, that the sulphitation process is the best method for Louisiana conditions, and that we have to sulphur highly to obtain the best results.

OPEN KETTLE HOUSES.

We have seen in the foregoing chapter that when we use sulphitation which has been found to be the most ideal process of clarification for Louisiana cane juice, the greater portion of the sulphur dioxide added to the raw juice is eliminated during the process of manufacture and only very little of it is left in the sugars and molasses. However, the absolute percentage of it in molasses is far in excess of the limit set by Food Inspection Decision No. 76.

All these products were made by the vacuum process by which the greater portion of the sugars and molasses are manufactured in Louisiana. But a number of houses use the old open kettle process. In these factories the boiling of the juice to syrup and to grain is not effected under a partial vacuum, but in open vessels. While in the former process the air is rarified, in the second it has free access to the products. For this reason oxidation takes place very rapidly in the latter, and the sulphur dioxide is quickly reduced by being converted into sulphuric acid or sulphate.

At the Sugar Experiment Station we use the vacuum process exclusively and are not well equipped for experiments with the open kettle process on a reasonable scale. But a study of the sulphitation process as practiced in open kettle houses has been taken up by the United States Department of Agriculture, being carried out by Dr. H. W. Wiley and Mr. A. H. Bryan at the Evergreen Plantation of Messrs. Holloway and Holloway. The results of these experiments have not yet been published, but samples of the molasses and sugars made were received and analyzed at the Sugar Experiment Station.

Three runs were made in the experiment at Evergreen Plantation; one with a certain quantity of sulphur, one with about half of that amount, and one without sulphur. The molasses from the first run tested 0.0272 per cent of SO_2, and that from the second 0.0049 per cent. These figures show in the first place that the quantity of sulphur dioxide added to the raw juice in the second run, was less than the limit found by our experiments (0.06 per cent, see page 40). Otherwise the quantity of sulphur dioxide would be found to be about equal to that in the first run, provided that both molasses were made under the same conditions.

Even the molasses made with the larger quantity of sulphur contains considerably less SO_2 than the maximum amount permitted by Food Inspection Decision No. 76. This is easily explained by the fact stated above that in this process oxidation of the sulphur dioxide can take place very freely, the air not being excluded. Two other open kettle molasses, analyzed at the station, corroborated this result. They contained 0.0266 and 0.0330 per cent of sulphur dioxide.

SYRUP HOUSES.

The process used in these sugar houses which manufacture only syrup, is somewhat similar to that employed in open kettle houses. The juice is boiled in open pans and is therefore always exposed to the action of the atmospheric oxygen.

From this we should expect a small percentage of sulphur dioxide in the finished syrup. But another factor has to be considered. While the sugar manufacturer tries to turn out all of the sucrose contained in the cane as sugar crystals, the syrup maker wants to make a semi-liquid product which must be free of crystals. To attain this end, he tries to invert a large enough quantity of sucrose to prevent any crystallization in the finished syrup. For this reason juices intended for syrup making are always carried highly acid, around about 2 cc n/10 acidity. We know from our considerations on clarification that in this case a very large percentage of sulphur dioxide remains in solution, and the finished product will be accordingly high in sulphur dioxide. A large variation of sulphur dioxide in the clarified juice may be expected depending on the quantities of sulphur and lime used in clarification, and we can foresee a corresponding range in the quantity of sulphur dioxide in the syrup.

Syrups analyzed at the station laboratory have given the following figures: 0.0162, 0.0196, 0.0292, 0.0332, 0.0340, 0.0350, 0.0357, 0.0431, 0.0684, 0.1157, 0.1520 per cent of sulphur dioxide. Most of these figures are below or near the limit of 0.035 per cent. But three of them are far above the limit. It is not impossible that the two samples with 0.1157 and 0.1520 per cent received a second treatment with sulphur fumes at some stage after clarification.

DISCUSSION OF THE RESULTS AND CONCLUSIONS.

We have seen in the preceding chapters that it is mainly the vacuum houses and perhaps some syrup manufacturers that would be affected by a definite enforcement of Food Inspection Decision No. 76. But they constitute by far the greater part of the sugar interests of this State. The sugar manufacturers working with modern effects and vacuum pans may use less sulphur than open kettle houses, and their products will still contain a quantity of sulphur dioxide far above the limit of 0.035 per cent. They may even cut down the sulphur used in clarification without reducing it in their molasses. And if they were to use so little sulphur that the molasses contains less than 0.035 per cent, a large part of the impurities which we can at present remove from the cane juice, would remain in it and render our final products, sugar as well as molasses, less pure. This can not possibly be the object of a Pure Food Law. It has to be proven yet that syrups or molasses containing quantities of 0.2 per cent of sulphur dioxide, about the highest that may be found in Louisiana products, are actually poisonous, or injurious to health. No indications of this character have, to our knowledge, ever been obtained anywhere, and it is unfair to discredit an article without having definitely proven its harmful character. The results of physiological experiments with sulphur dioxide, sulphites or even with salts of oxysulphonic acids, cannot be directly applied to food products, as Kerp has definitely shown. He makes the following statement, on the ground of a large series of experiments.[1] "The effect of sulphur dioxide depends on the nature of the foodstuff, and even more than that, it is influenced by the conditions under which it is taken." For this reason there is only one way of finding out whether sulphur dioxide, when taken with syrups or molasses, is harmful. This is to experiment with the products themselves. Investigations of this character have been carried out by the Sugar Experiment Station and the Louisiana State Board of Health, and the results have already been discussed on page 21. They have not disclosed any harmful effect on the human system brought about by using Louisiana syrups and molasses.

Our chemical investigations on the question offer an explanation for these results. Rost and Frantz have proven (see page 21) that the poisonous effect of a certain combination containing sulphur dioxide in some form can be predicted by the quantity of free sulphur dioxide liberated by it under the circumstances, and that this free sulphur dioxide can be determined by the iodine absorption. We have shown by our studies that even our factory syrups contain only a very small quantity of free sulphur dioxdie and it is more than probable that the final molasses will contain only traces of it. The experiments now in progress on this question, will undoubtedly give us additional evidence on this point and enable us to explain why sulphur dioxide drunk with water, or sulphite taken in capsules, as administered by Dr. Wiley, will produce harmful effects, and why, on the other hand, syrups and molasses, made by the sulphitation process are perfectly harmless, besides being purer than products made without sulphur.

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[1] Chem. Ztg. 31, 1062.

CLARIFICATION WITH HYDROSULPHITES.

The first discovery[1] of the formation of a new acid by the action of zinc or iron on sulphurous acid was made by Berthollet about one hundred years ago, but it was not until 1854 that Schoenbein observed the important fact that these solutions instantaneously and completely decolorize indigo solution. Sulphurous acid itself acts much more slowly than after having been treated with zinc. Schutzenberger took up the study of the new acid and came to the conclusion that the following reaction takes place:

$$3\,Na\,H\,SO_3 + Zn = Na\,H\,SO_2 + Zn\,SO_3 + Na_2\,SO_3 + H_2O.$$

He called the acid $H_2\,SO_2$ hydrosulphurous acid, and its salts hydrosulphites. The formula H_2SO_2 was generally accepted; but Bernthsen showed in 1882 that the above equation is not correct, that it must be replaced by the following:

$$4\,Na\,HSO_3 + Zn = Na_2\,Sn_2\,O_4 + Na_2\,SO_3 + Zn\,SO_3 + 2H_2O$$

and that the reaction between Zn and SO_2 is as follows:

$$Zn + 2SO_2 = Zn\,S_2O_4.$$

Moissan made the sodium salt by the action of sulphur dioxide on alkali hydrides:

$$2Na\,H + 2SO_2 = Na_2\,S_2O_4 + H_2.$$

and Nabl, by treating zinc dust, suspended in absolute alcohol, with sulphur dioxide, obtained the salt $Zn\,S_2O_4$.

It was again Bernthsen, who succeeded in preparing the crystallized sodium salt in such a state of purity that an analysis could be made. It was proven that the ratio of sodium to sulphur was 1:1, not 2:1, as assumed by Schutzenberger. The formula $Na_2\,S_2O_4\,2H_2O$ was thus established for the sodium salt.

Solutions of hydrosulphites are very unstable, and even the solid salt just mentioned had to be kept under alcohol to avoid decomposition.

Finally the Badische Anilin und Soda Fabrik in Ludwigshafen, where Bernthsen is one of the directors, could patent a preparation with excellent keeping qualities. It had been observed that by dehydrating the hydrated sodium salt a perfectly stable product could be obtained. This is done by digesting the hydrated salt with a hot, strong solution of sodium hydroxide. The latest process giving more satisfactory results is to crystallize the product from alcohol of a certain strength at a certain temperature. The preparation made by this method is called Blankit and has taken the place of earlier preparations which were sold under the trade names of Hydrosulphite BASF, Hydrosulphite NF and zinc sodium hydrosulphite. Another substance is sold in France under the name of Redo; it is calcium hydrosulphite in form of a paste and is not near as active or stable as Blankit.

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[1] See Stiegelmann Z. Ver Zuckerind, 56, 1009.

A new step in the chemistry of the hydrosulphites was the observation that hydrosulphites react with aldehydes, especially formaldehyde, just like the sulphites do. A double compound is formed of the formula:

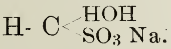
$$2\ CH_2O\ Na_2\ S_2O_4.$$

This product is known on the market as Eradite A. Its properties are different from those of hydrosulphite itself, in so far as it reduces indigo solution only at high temperatures.

It was soon found that Eradite is not a uniform substance, but that it could be split up into two components:

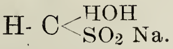
$$2CH_2O\ Na_2\ S_2O_4 + H_2O = CH_2O\ SO_3H\ Na + CH_2O\ SO_2H\ Na.$$

The second of these two products proved to have the entire reducing power of Eradite itself; it is the active principle of Eradite. The compound CH_2O, SO_3 H Na is nothing but the sodium salt of the well-known formaldehyde sulphurous acid or formaldehyde oxysulphonic acid, of this constitution:



$$\mathrm{H\text{-}\ C} < \begin{array}{l}\mathrm{HOH}\\ \mathrm{SO_3\ Na.}\end{array}$$

The compound CH_2O, SO_2H Na evidently is a derivative of the hypothetical acid $H_2\ SO_2$, sulphoxylic acid, and has the probable constitution:

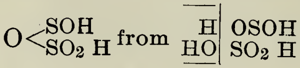


$$\mathrm{H\text{-}\ C} < \begin{array}{l}\mathrm{HOH}\\ \mathrm{SO_2\ Na.}\end{array}$$

The salts of sulphoxylic acid itself have not been obtained, but it is not impossible that they will be prepared some day. The compound CH_2O, SO_2H Na is sold under the trade name of Rongalite C.

It does not act perceptibly in the cold, but must first be split up into its components by heating when the sulphoxylic acid develops its full effect.

The fact that Eradite is a mixture, led some investigators to believe that sodium-hydrosulphite itself also is a mixture of ordinary sulphite and of sulphoxylate. But not a single fact has been found to corroborate this assumption. It is most probable that hydrosulphurous acid is an anhydride of sulphurous and of sulphoxylic acids and has this composition:



$$O<\begin{matrix}SOH\\SO_2\,H\end{matrix}\ \text{from}\ \begin{array}{r|l}\overline{H} & OSOH\\ \underline{HO} & SO_2\,H\end{array}$$

When it is treated with formaldehyde, it is decomposed as described above.

Blankit and Rongalite C. are perfectly stable, if kept in a cool place and in well-stoppered containers.

Hydrosulphites are used on a commercial scale mainly in two industries, the dyeing and printing industry and the sugar industry. During the campaign of 1885-86 solutions of hydrosulphites made from zinc and sulphurous acid were first used in some beet factories in Europe, and the process was patented in 1886 by Englert and Becker of Prague. The results obtained were good, but the cost of the process was entirely too high. Then came the well-known Ranson patents dating back to 1896. According to this process the hydrosulphite was to be formed within the liquid to be decolorized. The substance was treated with sulphur dioxide or bisulphite, and then zinc dust or specially prepared metallic tin was added. It was claimed that if tin were used, all of the tin would subsequently be removed by heating and filtration, having been precipitated as oxide or sulphide. Both of the processes described have, for a number of years, been used by molasses refiners in this country.

Dr. Stubbs and Prof. Ross carried out an extensive investigation on the composition and use of "Sulphine" and "Boxyde," published in Bulletin No. 11 of the Louisiana Sugar Experiment Station, 1891. "Sulphine" was found to be a commercial preparation of sodium bisulphite, and "Boxyde" nothing but zinc dust. Either of these two discolorized molasses to some extent, but the mixture of the two gave the maximum effect. The reasons for this behavior are obvious from the fore going. Dr. Stubbs advised the planters of the State to make use of those preparations and reap the profit otherwise going to the middlemen.

Since the appearance on the market of pure preparations of hydrosulphites all these processes have become dispensable, and the danger of contaminating food products with poisonous substances like tin or zinc can be avoided. Numerous experiments have in consequence been made with hydrosulphite during the past two or three campaigns, mostly in beet sugar houses. A few cane sugar factories have also been using it during the last grinding season. Very recently Prinsen Geerligs[1] expressed himself as follows on this question: "If one should intend to clarify with sulphurous acid, the purpose may be accomplished more easily and rapidly with the use of hydrosulphites."

The results obtained in European beet sugar factories have been very encouraging. It was found that the bleaching power of hydrosulphite is 20-40 times as great as that of sulphur dioxide. It decolorizes in alkaline as well as in acid solution, while sulphur dioxide is effective only in an acid medium. Hydrosulphite itself having an acid reaction, diminishes the alkalinity or increases the acidity to a slight extent, but not enough to be of any consequence in most cases, because quantities of about 0.02 per cent are usually sufficient to bring about the desired effect. Hydrosulphite acts mainly on certain coloring substances which are formed during the boiling of juice and which, on further heating, are converted into true caramel. But this latter itself does not seem to be bleached very markedly. For this reason some manufacturers prefer to use it at an early stage of the process of sugar making. However, it was also found that in some cases the bleached products darken very rapidly upon exposure to the air, while in others the decoloration is permanent. It has been impossible so far to discover any laws governing these relations, but some manufacturers decided to use hydrosulphite in the pan, because in this case the products are exposed to the air only the shortest possible time. It has further been observed that hydrosulphites tend to reduce the viscosity of the masse cuite, and to improve quality and quantity of the output.

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[1] De Fabricatie van Suiker uit Suikerriet, page 180, (1907).

The general opinion of manufacturers is that the use of hydrosulphite means a great saving of the expensive bone black and a great advancement over ordinary sulphitation.

In a paper published in the Journal des Fabricants de Sucre, February 13, 1907, the author states: "As regards the use of hydrosulphites in sugar factories, it will be mainly the establishments producing white granulated sugar for direct consumption, where this bleaching agent ought to be of the greatest service." And again: "It is certain that a manufacturer, after having seen the surprising effects of hydrosulphite, will never abandon its use."

Methods which enable us to manufacture sugar for direct consumption and light colored molasses without too great an expense, are of the greatest importance in this State, as everyone knows. But there is still another point to be considered. We do not know as yet whether or not the use of sulphur will finally be restricted for products entering interstate commerce. If it be done, then a process, by which we can make fancy products without the use of sulphur, will be of extreme value. These considerations induced us to conduct some experiments at the Experiment Station laboratory and sugar house.

The use of hydrosulphites as a clarifying agent of cane juice was first studied. The addition of only one part per 100,000 bleaches the juice completely. But the decoloration is not permanent. After a few hours' standing on the air, the original color is restored, and more hydrosulphite must be used to obtain a lasting effect. The same is true when cane juice is clarified with lime and hydrosulphite, first liming to slight acidity, and then adding a small quantity of hydrosulphite. The juice is completely bleached, but the original color comes back during filtration. The clarification is turbid as is always the case, when lime alone is used. The exceedingly small amounts of hydrosulphite have no noticeable effect on this phenomenon or on the purity of the juice. The use of larger quantities of hydrosulphite at this stage of the process is out of the question on account of its present price—35 cents per pound.

Sugar house experiments confirmed the results obtained in the laboratory.

One clarifier of about 3,000 pounds of juice was, without previous sulphuring, limed, until a slight acdity remained, and one ounce of hydrosulphite was added before heating. A very light colored juice was obtained in this way, but it was milky, and when it was pumped over into the settling tanks, it assumed the same color as other juices treated with lime alone. There was no increase in purity over that obtained with lime alone. These results showed clearly that hydrosulphite should not be used at such stations where the products are exposed to the air, but rather in the effects or in the pan. In one experiment about two ounces of hydrosulphite were drawn into the effects with 3,000 pounds of juice, clarified with lime alone. The syrup resulting showed no marked improvement over that obtained without hydrosulphite.

At last the hydrosulphite was added in the pan, and these experiments were studied a little more fully because other investigators had found before that it is most advantageously used at that stage of the process of manufacture. The only way in which comparable results could be obtained with the equipment of our sugar house, was to start a strike without hydrosulphite, then make a cut and build up on the nucleus left with syrup to which hydrosulphite had been added.

In one run a quantity of hydrosulphite was added, amounting to 0.025 per cent, on the weight of the syrup. Soon after the first portion of the hydrosulphite had entered the pan, the color of the masse cuite turned from brown to a very light amber color, and remained that way during the entire time of boiling. The color darkened to some extent in the mixer and in the centrifugal, but even then it was still very light as compared to the portion of molasses which had not been treated with hydrosulphite. No inversion due to the action of hydrosulphite took place.

A slight difference in the color of the sugars could be noticed. That made without hydrosulphite polarized 94.1, and the other 96.5. A few centrifugal charges were washed with the same amount of water in both cases. That made with hydrosulphite polarizing 97.9, was just a shade lighter than the other, which showed 97.7 per cent of sucrose. The sugar made with hydrosulphite appeared rather gummy as compared to the other, and this observation does not at all agree with the results of others. It is the unanimous opinion of all other investigators that massecuites treated with hydrosulphites are less viscous, and one sugar boiler in this State who tried the new preparation, remarked that it seemed to "break the gums." I trust that further investigations will clear up this point.

There is still another difficulty. One of our objects in studying the use of hydrosulphites was to manufacture light-colored products without employing sulphur fumes. If we test products containing hydrosulphites in the same way as is done in the determination of sulphites, we find a certain amount of sulphur dioxide. The syrup of our run tested 0.0363 per cent of SO_2 and the molasses 0.1086 per cent.

We therefore made a second run in the same way as the first, but used no hydrosulphite in clarification and only 0.007 per cent of hydrosulphite on the weight of the syrup. Now, the molasses analyzed only 0.0100 per cent of SO_2, and what is very remarkable, the molasses was just as bright as that made in the first run and has not darkened perceptibly during storage. The sugar made with hydrosulphite again polarized higher. We had intended to make a few more experimental runs with Blankit and also with Rongalite C, but unfortunately the small vacuum pan which we wanted to use for this purpose did not hold the vacuum, and we had to give up our plan.

The results so far obtained are not uniform and definite conclusions cannot be drawn until more data and agreeing results can be obtained.

There can be no more objection to the use of hydrosulphites than to the use of sulphur. We can not detect any hydrosulphite in the finished product, because it has been converted into sulphite or otherwise decomposed. The quantity used is exceedingly small and does not reduce the strength of the product. In the third place, it does not conceal any inferiority, from the legal standpoint, because color is not an appropriate means of judging the quality and food value of a syrup or molasses.

CLARIFICATION WITH CAMORSITE.

Another preparation has recently been offered to some planters and to the Sugar Experiment Station under the trade name of camorsite, to be tried as a clarifying agent. It consists of a heavy white powder, which is partly soluble in water.

An analysis of the material gave these figures:

Volatile matter	1.54 per cent
Insoluble in hydrochl. acid	8.67 per cent
Alumina	31.32 per cent
Baryta	57.45 per cent
Undetermined	1.02 per cent
	100.00 per cent

The fact that the preparation contains a large percentage of barium whose soluble compounds are very poisonous, necessitated an investigation on its use from the standpoint of the Pure Food Law.

About 90 per cent of the substance consists of an aluminate of barium. But the barium oxide is in excess of what the formula Ba Al_2O_4 calls for. The ratio of aluminum to barium in barium aluminate is 2:1, in Camorsite it is found to be 2:1.22. For this reason the preparation is strongly alkaline: 1 g of it shows an alkalinity equal to 7.25 cc of normal hydrochloric acid.

Camorsite is partly soluble in water. After boiling it with water the insoluble part amounts to 27.5 per cent of the original weight. The solution has a specific gravity of 1.033 at 21 degrees C.; 100 cc of this solution contains 0.638 g of alumina (= 0.338 g of aluminum) and 2.655 g of barium oxide (= 2.377 g of barium). The ratio of aluminum to barium is 2:2.8. The solution in water, therefore, contains a much larger excess of free barium oxide than the solid material and is consequently very strongly alkaline; 100 cc of the solution neutralizes 34.1 cc of normal hydrochloric acid. The solution, on standing in the air, soon becomes turbid, owing to the formation of insoluble barium carbonate. It must therefore always be kept in well-stoppered containers.

These analytical data proved the material to be very similar or identical with the barium aluminate with which Zamaron and Dupont conducted a number of experiments in France, in 1902 and 1903.[1] These authors claim that the use of barium aluminate offers the following advantages with beet juices:

1. Increase in purity of 1.5.
2. Increase of the saline quotient up to 1.5.
3. Elimination of lime salts.

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[1] Bull. Assoc. Chim. Sucr dist., 21, 59.

4. Reduction of the quantity of lime needed by 50 per cent, and possibility to do without the second carbonation.

5. Decoloration of the juices and syrups.

6. Easy filtration.

7. No incrustations in the evaporators.

A series of laboratory experiments were made at the station, using Camorsite in addition to lime, or in combination with the sulphitation process. Other investigators had found before, and we could confirm this, that the solid preparation cannot be used directly, because it dissolves only very slowly, and that a solution of it should always be employed.

The use of Camorsite without that of lime in the cane sugar industry is entirely out of the question. If employed without sulphitation we would have to introduce into the juice a quantity of water amounting to 5 per cent of the total and with sulphitation up to 16 per cent. Besides this, the precipitate produced by it is flocculent and very voluminous; after settling, it occupies over one-half of the volume of the liquid. In the third place, the cost per clarifier of 1,600 gallons would be about $8 to $10 without, and three times as much if used with sulphitation. The decoloration obtained by neutralizing the juice with Camorsite, was good and permanent.

We next made some experiments with a combination of lime and Camorsite. A juice which showed a purity of 82.26 normal, gave after clarification with lime alone 82.52. When we used 3 cc of Camorsite solution and neutralized the remaining acidity with lime, a purity of 82.92 was obtained. By increasing the quantity of Camorsite solution to 10 cc, the purity could be raised to 83.48.

When Camorsite was used in connection with sulphitation the results obtained were less good. The same juice that had been used before, was sulphured to 5 cc acidity and then treated with lime until a very slight acidity remained. The purity of the clarfied juice was 83.86. When 3 cc of Camorsite solution were substituted for an equivalent quantity of lime, the purity was found to be 83.80. The use of 10 cc of Camorsite solution resulted in a purity of 83.76.

Even if better results than these could be procured with the use of Camorsite, it could not be recommended for two reasons. The cost per clarifier of 1,600 gallons would, according to Mr. Camors' statement, amount to $1.50, which is entirely too high.

The second reason, however, is a much stronger one, and has always prevented the use of compounds of barium which have often been proposed to be used in the sugar industry. While barium salts can be entirely removed by proper processes—we could not detect even a trace of it in the ash of our juices treated with Camorsite—there exists a great danger of the products being contaminated with them through improper use by inexperienced workmen. This consideration alone should prevent the use of barium compounds in the manufacture of articles of food, especially in such cases where other processes are available giving equally good results.

TIN AND ZINC IN SUGAR PRODUCTS.

THE OCCURRENCE OF HEAVY METALS IN LOUISIANA SOILS AND CANE.

Salts of tin and zinc were by the Department of Agriculture named among the deleterious substances which were being used by the Louisiana sugar planters. There is no doubt that such compounds are harmful and that their use should be restricted as much as possible.

The way in which zinc or its compounds are employed has already been fully discussed in the chapter on hydrosulphites.

Tin is usually used in the form of "tin crystals" or "rock compound." Both of these are commercial brands of protochloride of tin. A solution of these in water is applied as a wash in the centrifugals to brighten the sugar. Protochloride of tin is a very strong reducing agent and acts very much like hydrosulphite.

Th. A. Havemeyer[1] claimed in 1879 to have been the originator of this method of decolorizing sugar solutions and stated that he discontinued its use in 1869, but that, to his knowledge, it was largely used in Louisiana. The same subject aroused very great interest in London, two years later, and a meeting of the West India Committee was called where the use of stannous chloride was strongly condemned.

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[1] Sugar Cane, XI, 30.

In 1904, Pitsch[2] tested several sugars from Demerara for tin, and found 0.0014-0.042 per cent tin (calculated as chloride).

Last year a large number of Louisiana syrups and molasses were analyzed for tin and zinc at the station, and in none of them could we detect either of these two metals. It was found that the method which is usually employed for the detection of heavy metals in foodstuffs, was not directly applicable to the analysis of syrups and molasses. Attention was called to this point at a meeting of the Louisiana Section of the American Chemical Society, January, 1907, and a committee was appointed to investigate into this matter, consisting of Prof. L. W. Wilkinson, chairman; C. W. Harrison and the writer. Two months later this committee submitted the following report:

"Analyses made by Munson's method,[1] gave the most discrepant results tending towards too high figures for both tin and zinc in almost every case. This shows in the first place that there is no danger of the volatilization of tin, as has been feared. This volatilization seems to be prevented by the action of either the sulphuric acid or by some constituents of molasses. However, both tin and zinc were in every case found to be contaminated with foreign substances. The separation of copper and tin is, in Munson's method, effected by extracting the mixture of the sulphides with hot ammonium sulphide on the filter. Now, it is a well-known fact that this latter reagent dissolves appreciable quantities of copper sulphide, which, on acidifying, is reprecipitated with the tin.

"The difficulties are still greater in the case of zinc. Before precipitating this substance with hydrogen sulphide, all of the phosphoric acid is removed, together with small quantities of iron and aluminum, by adding an excess of ferric chloride solution, and precipitating by boiling with ammonium acetate. It was found in every instance that after this procedure, the zinc never was thrown down as a white precipitate, but had a gray, brownish or even black color, if very small quantities of zinc were present.

"On examining this precipitate it was found that besides zinc, it contained iron, cobalt and some times even copper.

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[2] Z. Ver Zuckerind, 54, 353.

[1] Bull. 65, Dept. Agriculture, Div. of Chemistry, page 53.

"The cobalt comes from the iron chloride used for precipitating phosphoric acid. One member of the committee examined the so-called 'pure' iron chloride, and found an appreciable amount of cobalt. This explains the fact that a second treatment with iron chloride and ammonium acetate, as suggested by Munson, does not remedy the difficulty.

"The question arose now: How can these difficulties be avoided and how can the method be simplified, if possible?

"It was found, that the incineration of the molasses can be very easily and rapidly effected in the following way: 50 g of molasses are mixed in a 5-inch porcelain dish, with 15 cc of concentrated sulphuric acid, and stirred. In less than one minute the whole mass carbonizes without excessive frothing. Now 5 cc of concentrated sulphuric acid are added and thoroughly mixed with the char. The dish is then placed on a sand bath or an asbestos plate, and heated to a moderate heat. The temperature is gradually raised and the dish heated at last over a naked flame. In this way the incineration can be effected in 2-3 hours.

"In order to improve the separation of tin and copper, sodium sulphide was substituted for ammonium sulphide. But it was found that even then some copper sulphide was dissolved. However, this could be removed by heating the tin oxide after igniting with 35 per cent nitric acid, diluting with water, filtering, returning the filter to the original crucible and igniting again. In this way 8.9 and 9.3 milligrams of tin oxide were found, where 9.3 had been added.

"The zinc, on the other hand, had to be freed from iron, cobalt and copper. The oxide which was first obtained by Munson's method and weighed, in two experiments, 15 and 12 milligrams, was dissolved in hydrochloric acid, and this solution poured into an excess of sodium hydroxide, containing hydrogen peroxide. After heating on a water bath for 15 minutes and filtering, the solution was acidified with acetic acid, boiled, and hydrogen sulphide passed through the liquid. The precipitate was ignited again and weighed. 11.1 and 9.2 milligrams were found instead of 9.1."

The figures agree much better with the actual amount of tin and zinc than those obtained by the original method, and it is recommended to purify the first precipitate in the described manner.

It has already been stated that we could not find any tin or zinc in any of the commercial samples examined. But even if small amounts of these metals should once be found, it would not be a sufficient proof that they have been wilfully added. Kramer[1] found copper-oxide in cane ash, and appreciable quantities of this substance are found in Louisiana syrups and molasses. A part of this probably originates from the copper coils or copper defecators.

Mr. J. A. Hall, Jr., studied this point a little more fully by testing soil, cane and cane juice for the presence of heavy and other metals, and his report reads as follows:

"Thirty liters of D. 74 juice of 15 degrees Brix were fermented, distilled and the residue ashed. One hundred grams of this ash were taken and examined for heavy metals. Fourteen milligrams (0.0140 gr.) of tin oxide and forty-one milligrams (.0410 gr.) of Cu_2S were found.

"Two hundred and fifty grams of soil, taken from plats 8B and 7D, were digested at the temperature of boiling water with 600 cc H CL (Sp. gr. 1.115) for 24 hours. The solution gave a precipitate with H_2S of 10 milligrams (.0100 gr.) in which precipitate both Sn and Cu were identified, but not separated quantatively.

"Both tin and copper were found in the ash from the entire cane, but were not determined quantatively.

"It was also attempted to discover zinc in the above, but the results were negative, as were those for titanium, barium and strontium."

While zinc could not be found in the soil and cane of the Experiment Station, it may occur in other localities where cane is planted. According to Risse[2] it seems to be a constituent of all plants grown on a soil which contains zinc.

It will therefore be necessary to be very careful in interpreting the results of analyses of syrups and molasses which gave positive results as regards the occurrence of metals like copper, tin or zinc.

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[1] Proefstation Oost-Java, No. 49, 42.

[2] Sachs, Experimental Physiologie, 153.

ERRATA.

Page 12, line 2, from top, read "up" instead "of."

Page 23, line 18, from bottom, "involved" instead of "involxed."

Page 24, line 11, from top, read "hydrogen" instead of "hydrogene."

Page 31, line 6, from top, strike out "33 and."

Page 34, line 18, from bottom, read "36 and 37," instead of "35 and 36."

Page 46, line 9, from bottom, insert "50-63" after "pages."

Page 48, line 2, from top, read "degrees" instead of "degree."

Page 52, line 3, from bottom, insert "runs" after "results of."

Page 62, line 2, from bottom, strike out "long."

Page 68, line 18, from top, read "$Na_2\ S_2\ O_4$" instead of "$Na_2\ Sn_2\ O_4$."

Page 68, line 9, from bottom, insert "in the neutral salt" after "sulphur."

Page 70, line 3, from bottom, read "decolorized" instead of "discolorized."

Page 76, line 14, from bottom, insert "per liter" after "solution."

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Agricultural Experiment Station

OF THE

Louisiana State University
and A. & M. College,

BATON ROUGE.

FEEDING

"BLACKSTRAP" MOLASSES

TO YOUNG CALVES.

T. E. WOODWARD and J. G. LEE, Jr.

BATON ROUGE:
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Louisiana State University and A. & M. College

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INTRODUCTION.

By W. H. Dalrymple.

The primary object of this experiment, the results of which are herewith appended, was to determine whether or not low-grade sugar-cane molasses (blackstrap) could be used as a supplement to skim-milk, or, in other words, take the place of the fat that had been removed from the whole-milk, for calf-feeding purposes. In Hammond, La., and neighborhood, where this experiment was conducted, and where the whole-milk, itself, is the chief marketable product, it pays better to dispose of the milk than to use it for calf-feeding and raising. And, as commercial butter-making is not a special feature in the industry there, skim-milk is not available in sufficient quantity for this purpose, even were it practicable to use a cheap substitute for the fat removed from the whole-milk. If butter-making had been the leading feature in the dairy industry at Hammond, the skim-milk, supplemented by a substitute for the removed fat (butter), would have lessened the cost and made calf-raising by the dairymen a more profitable undertaking. Under present conditions, however, where the greatest profit is obtainable from the disposal of whole-milk, unless some complete, or almost complete, substitute can be had, the cost of raising the calf would amount to more than the worth of the calf itself.

Consequently, in order to build up the dairy herds from the local calf-crop, some cheap complete substitute for the whole-milk would have to be adopted, which is sometimes done by employing different meals and rendering the mass fluid by the addition of hay-tea, etc., and the young animals induced to consume solid food as early as possible. With an abundance of available skim-milk, substitution might be made for the fat taken from the whole-milk, by the addition of corn meal, or other material of a fat-producing character; but which would be profitable in the raising of calves, only, where butter or cream production was the chief object sought.

This question of feed-substitution has a wider application than merely to the raising of young calves, or other young animals. It applies to the feeding of all varieties of domestic animals upon the farm. A very forcible illustration of this is to be found in the case of many of the western farmers who raise timothy hay. Their experiment stations have proved to them that shredded corn fodder is equal in feeding value to their timothy. Consequently, they substitute shredded corn fodder for feeding purposes at home, from which they secure equally good results, and dispose of the timothy hay to us, and others, at most profitable prices. Did they feed the timothy hay at home, and not utilize their corn fodder, it would be equivalent to the dairyman feeding his whole-milk to his calves, when he could substitute some cheaper material for it and sell the milk on the market at a much higher figure than the substitute costs.

As may be inferred from the above remarks, he who feeds the most expensive materials is not the best nor most intelligent feeder.

The gist of our remarks might be taken to apply also in the matter of utilizing high-priced concentrated feeds for dairy cows, and feeding excessive amounts, irrespective of the requirements of the animal or animals. From records which we have seen, we are of the impression that some dairymen feed too heavily of cotton seed meal, for instance, for best results, so far as either the animal or its product is concerned. The amount in such cases might be reduced with benefit and profit, and the protein (nitrogenous) requirement made up from other, and perhaps cheaper sources.

This matter of intelligent substitution is one which every feeder of farm animals ought to very seriously consider, and try, if possible, to thoroughly understand, as it may be the means of affecting his bank account, either one way or the other, very materially at the end of the year; and this applies to dairymen with greater force, perhaps, than to any other class of livestock owners.

We desire to emphasize the fact, that although the results obtained from the use of "blackstrap" in calf-feeding were not as satisfactory as could have been hoped for, these results do not apply to molasses in the feeding of adult animals, as we have abundant evidence to show, that not only has it been fed with most excellent results to mature stock of all kinds, but that it is our cheapest source of carbohydrates in the State. The results of this experiment proved molasses to be laxative and produced fermentation and ''scours'' in young calves, which, however, was not due, solely to the molasses, as such, but to the contained sugar, as pure sugar, itself, produced similar results.

Although the cause of the trouble may have been due to several factors, it is possible that the delicate mucous-membrane of the stomach and intestines of the young calf is more susceptible to irritation, or over-stimulation, produced by the sugar.

The calf-feeding experiment was ably conducted by Mr. T. E. Woodward, of the Dairy Division, National Bureau of Animal Industry, and Mr. J. G. Lee, Jr., representing the State Experiment Station.

Feeding "Blackstrap" Molasses To Young Calves.

By T. E. Woodward and J. G. Lee, Jr.

The calves used in this experiment were mostly furnished by Mr. W. W. Nott, three miles from Hammond, La., on his farm, as was also the skim-milk. The young calves were kept in individual pens 4x6. Part of the time they were allowed to run at will in a lot during the day, but were placed in their pens at night. The pens were cleaned out twice daily, and the young animals were bedded with sawdust. Kreso (a coaltar preparation) was rubbed, or sprayed, on the calves to keep them free from ticks and consequent irritation. The older calves ran out in pasture with the cows during the day, and at night were tied in their individual stalls.

Thirteen calves, in all, were fed blackstrap molasses. The young calves received from 4 to 6 pounds of skim-milk twice daily; the object being to under-feed, rather than over-feed them.

The older calves received 6 to 8 pounds of skim-milk twice daily. These would have been fed more, but for the fact that this amount was all they had previously been accustomed to.

The young calves were given all the hay and grain they would clean up; the older ones received about 2 pounds of grain daily.

The grain consisted of two parts bran, two parts corn meal, and one part oil meal. The only available roughage was oat hay and crab-grass hay.

In no instance did the molasses fail to scour the calves. The amount required to produce scours varied all the way from one-twentieth of a pound, in the case of the very young calves, to seven-tenths of a pound in the case of the seven months' old calves.

The molasses first used was slightly sour. Fresh molasses was, however, secured and heated to a temperature of 180 F., or more, but still the scouring continued. Pasteurization of the skim-milk did not have any beneficial effect. Exercise seemed to make no difference, so far as the condition of the calf's bowels was concerned. Granulated sugar produced the same results as an equivalent amount of sugar contained in the molasses. Milk sugar proved laxative also, but about twice as much of it can be fed. Or, in other words, two ounces of milk sugar has the same effect as one ounce of cane sugar. When the calves scoured their droppings were sour-smelling; but when they did not scour, their droppings did not smell sour.

Several substances were fed along with the milk and molasses in the hope of finding something that would prevent scouring: Formalin, blood meal, and lime water proved useless. Common salt (Na Cl) had a slightly beneficial effect. Fifty grains of tannin in some cases enabled us to feed about one-half more molasses than it was possible to do without it; in other cases it seemed to be without effect. All of the substances mentioned, as well as the sugar and molasses, were fed mixed in the milk.

CONCLUSIONS.

On account of its laxative effect, "blackstrap" molasses can not be used as a supplement to skim-milk for calf feeding purposes in sufficient quantity to be of any practical value.

This laxative effect is due to the sugar content, rather than to any of the other constituents of the "blackstrap."

Scouring is caused by the fermentation of the sugar in the digestive tract.

Salt and tannin have a beneficial effect, but will not prevent scouring.

SAMUEL—Dropped May 23.

This calf was allowed to suck one week before we got it.

Date	Milk Fed		Amt. left in pail	Substance added		Condition	Weight
	Whole	Skim					
May 30 p.m.	4 lbs.	....	....	....		Good	....
31 a.m.	Not fed	....	....	....		“	....
p.m.	3	....	....	....		“	....
June 1 a.m.	3.5	.5	....	....		“	57.5 lbs.
p.m.	3.5	.5	....	....		“	....
2 a.m.	3	.7	....	....		“	....
p.m.	3	1	....	....		“	....
3 a.m.	2.5	1.5	1	....		“	....
p.m.	2	1.5	....	....		“	....
4 a.m.	2	2	1	....		“	....
p.m	2	2	....	....		“	....
5 a.m.	1.5	2.5	....	....		“	....
p.m.	1.5	2.5	.5	....		“	....
6 a.m.	1	3	1	....		Loose	....
p.m.	1	3	2.4	....		“	....
7 a.m.	1	3	2.1	....		“	....
p.m.	1	3	1.4	....		“	....
8 a.m.	....	4	1.2	1 oz. castor oil Astringent, T-spoon (2 pt. salol 1 pt. bis-subnit.)		“	62
p.m.	....	4				“	
9 a.m.	....	4				Good	....
p.m.	....	4	....	Molasses	Formalin	“	....
10 a.m.	....	4	....	.1	....	“	....
p.m.	....	4	....	.1	....	Loose	....
11 a.m.	....	4	....	.1	....	“	....
p.m.	....	4	....	.1	....	“	....
12 a.m.	....	4	....	.2	....	“	....
p.m.	....	4	....	.2	....	“	....
13 a.m.	....	4	....	.2	....	“	....
p.m.	....	4	....	.2	....	“	....
14 a.m.	....	4	....	.3	....	“	....
p. m.	....	4	....	.3	....	Better	....
15 a.m.	....	4	....	.3	....	Loose	61.5
p.m.	....	4	....	.3	....	“	....

SAMUEL—Continued.

Date	Milk Fed		Amt. left in pail	Substance added		Condition	Weight
	Whole	Skim		Molasses	Formalin		
June 16 a.m.		4		.3		Loose	
p.m.		4		.3		"	
17 a.m.		4		.3	.5 c.c.	"	
p.m.		4		.3	.5 "	"	
18 a.m.		4	3.5	.3	.5 "	"	
p.m.		4		.3		"	
19 a.m.		4		.3		"	
p.m.		4				"	
20 a.m.		4				"	
p.m.		4.5				Better	
21 a.m.		4.5				"	
p.m.		4.5				"	
22 a.m.		5				"	64.5 lbs.
p.m.		5				Good	
23 a.m.		5				"	
p.m.		5.5				"	
24 a.m.	Killed						

This calf did not drink with the appetite that most calves do; it was dull and weak, thus the reason for killing it. While molasses was being fed this calf scoured; when molasses was discontinued, its condition improved. The whole milk used was from a certain cow and tested 3.7% fat. The skim milk was fed fresh from the separator after first being heated to a temperature between 95° and 100°. The molasses was old and slightly sour.

HAMMOND—Dropped May 31.

Date	Milk		Substance added	Condition	Weight
	Whole	Skim	Molasses		
June 1 p.m.	1.5	....	....	Good	....
2 a.m.	3	....	....	"	....
p.m.	2.5	.5	....	"	....
3 a.m.	2.5	.5	1–20	"	45 lbs.
p.m.	2.5	.5	1–20	"	....
4 a.m.	2.5	.5	1–20	"	....
p.m.	2.5	.5	1–20	"	....
5 a.m.	2.5	.5	1–20	"	....
p.m.	2.5	.5	1–20	"	....
6 a.m.	2.5	.5	1–20	Loose	....
p.m.	2.5	.5	1–20	"	....
7 a.m.	.4	.5	1–20	"	....
p.m.	2.5	.5	1–20	"	....
8 a.m.	2.5	.5	1–20	"	48
p.m.	2.5	.5	1–20	Fair	....
9 a.m.	2	1	.1	"	....
p.m.	2	1	.1	"	....
10 a.m.	1.5	1.5	3–20	"	....
p.m.	1.5	1.5	3–20	"	....
11 a.m.	1	2	.2	"	....
p.m.	1	2	.2	Loose	....
12 a.m.	.5	2.5	.2	"	....
p.m.	.5	2.5	.2	"	....
13 a.m.	....	3	.2	"	....
p.m.	....	3	.2	"	....
14 a.m.	....	3	.2	Fair	....
p.m.	....	3	.2	"	....
15 a.m.	....	3	.2	"	50.5
p.m.	....	3	.2	"	....
16 a.m.	....	3	.2	"	....
p.m.	....	3	.2	"	....
17 a.m.	....	3	.2	"	....
p. m.	....	3	.2	"	....

HAMMOND—Continued.

Date	Milk		Substance added		Condition	Weight
	Whole	Skim	Molasses			
June 18 a.m.		3	.2		Loose	
p.m.		3	.2		"	
19 a.m.		4	.2		Better	
p.m.		4	.2		"	
20 a.m.		4	.2		"	
p.m.		4	.2		Loose	
21 a.m.		4	.2		"	55.5 lbs.
p.m.		4	.2		Fair	
			Molasses	Blood Meal		
22 a.m.		4	.2		Fair	
p.m.		4	.2		"	
23 a.m.		4	.2		Loose	
p.m.		4	.2		"	
24 a.m.		5	.2		"	
p.m.		5	.2		"	
25 a.m.		5	.2		"	
p.m.		5	.2	T-spoonful	Fair	
26 a.m.		5	.2	"	"	
p.m.		5	.2	"	Loose	
27 a.m.		5	.2	"	"	
p.m.		4	.2	"	"	
28 a.m.		5	.2	"	Fair	
p.m.		5	.2	"	"	
29 a.m.		5	.2	"	Loose*	63
p.m.		5	.2	"	"	
30 a.m.		5	.2 fresh		"	
p.m.		5	.2 "		"	
July 1 a.m.		5	.2 "		"	
p.m.		5	.2 "		Better	
2 a.m.		5	.2 "		"	
p.m.		5	.2 "		Loose	
3 a.m.		5	.2 "		"	
p.m.		5	.2 "		"	

*Turned out in lot during day.

HAMMOND—Continued.

Date	Milk		Substance added		Condition	Weight
	Whole	Skim	Molasses	Blood Meal		
July 4 a.m.	....	5	.2 fresh	....	Loose	....
p.m.	....	5	.2 "	....	"	....
5 a.m.	....	5	.2 "	....	"	....
p.m.	....	5	.2 "	....	"	....
6 a.m.	....	5	.2 "	....	"	67.5 lbs.
p.m.	....	5	.2 "	....	"	....
7 a.m.	....	5	.2 "	....	"	....
p.m.	....	5	.2 "	....	"	....
8 a.m.	....	5	....	....	"	....
p.m.	....	5	....	....	Better	....
9 a.m.	....	5	....	....	"	....
p.m.	....	5	....	....	Good	....
10 a.m.	....	5	....	....	"	....
a.m.	....	5	....	....	"	....

Date	Skim Milk	Substance added		Temperature	Condition	Weight
		Molasses	Blood Meal			
July 11 a.m.	5	....	T-spoonful	96	Good	....
p.m.	5	....	"	98	"	....
12 a.m.	5	1–20	"	96	"	....
p.m.	5	1–20	"	96	"	....
13 a.m.	5	1–20	"	96	"	72.5
p.m.	5	1–20	"	96	"	....
14 a.m.	5	1–20	"	99	Fair	....
p.m.	5	1–20	"	96	"	....
15 a.m.	5	.1	"	96	Good	....
p.m.	5	.1	"	96	"	....
16 a.m.	5	.1	"	98	"	....
p.m.	5	.1	"	96	"	....
17 a.m.	5	.1	"	96	Fair	....
p.m.	5	.1	"	98	"	....
18 a.m.	5	.1	"	97	Loose	....
p.m.	5	.1	"	97	"	....

HAMMOND—Continued.

Date	Skim Milk	Substance added		Temperature	Condition	Weight
		Molasses	Blood Meal			
July 19 a.m.	5	.1	T-spoonful	99	Fair	
p.m.	5	.1	"	96	"	
20 a.m.	5	.1	"	96	Good	76 lbs.
p.m.	5	·1	"	98	Fair	
21 a.m.	5			98	Good	
p.m.	5			96	"	
22 a.m.	5			97	"	
p.m.	5			97	"	
		Sugar				
23 a.m.	5	2.5 oz.		96	"	
p.m.	5	2.5		96	Loose	
24 a.m	5			96	"	
p.m.	5			96	Good	
25 a.m.	5	1 oz.		98	"	
p.m.	5	1		96	"	
26 a.m.	5	1		96	"	
p.m.	5	1		96	"	
27 a.m.	5	1.5		96	"	83.5
p.m.	5	1.5		96	"	
28 a.m.	5	1.5		96	"	
p.m.	5	1.5		96	Loose	
29 a.m.	5	2		95	Better	
p.m.	5	2		96	Fair	
30 a.m.	5	2		96	"	
p.m.	5	2		96	Good	
31 a.m.	5	2.5		95	Fair	
p.m.	5	2.5		96	Loose	

HAMMOND—Continued.

Date	Skim Milk	Substance added		Temperature	Condition	Weight
		Sugar	Tannin			
Aug. 1 a.m.	5			96	Loose	
p.m.	5			97	Fair	
2 a.m.	5			98	Good	
p.m.	5			96	"	
3 a.m.	5			96	Fair	85 lbs.
p.m.	5			96	"	
		Molasses				
4 a.m.	5	.1		96	Good	
p.m.	5	.1		97	"	
5 a.m.	5	.1		96	"	
p.m.	5	.1		96	"	
6 a.m.	5	3-20		96	"	
p.m.		3-20		96	Loose	
7 a.m.	5			96	"	
p.m.	5			96	Good	
8 a.m.	5			96	"	
p.m.	10*			96	"	
9 a.m.					Loose	
p.m.	5			96	Good	
10 a.m.	5	1-20		96	Fair	84
p.m.	5	1-20		96	"	
11 a.m.	5	1-20	25 gr.	95	Loose	
p.m.	5	1-20	25 "	96	"	
12 a.m.	4	1-20	25 "	96	"	
p.m.	4	1-20	25 "	96	"	
13 a.m.	4			97	"	
p.m.	4			96	"	
14 a.m.	4		Blood Meal	96	"	Kept in barn
p.m.			1 T-spoon	98	"	
			better gr'de			
15 a.m.	4		2 T-spoons	99	"	
p.m.	4		"	96	Better	
16 a.m.	4	1-20	"	97	Good	
p.m	4	1-10	"	96	"	
17 a.m.	4	3-20	"	96	"	81
p.m.	4	3-20	"	96	Loose	
			Tannin			
18 a.m.	4	3-20	50 gr.	98	"	
p.m.	4	3-20	50 "	98	Fair	
19 a.m.	4			98	Loose	
p.m.	4			96	"	

*By mistake.

HAMMOND—Continued.

Date	Skim Milk	Substance added				Temperature	Condition	Weight
		Molasses	Blood Meal	Salt	Milk Sugar			
Aug. 20 a.m.	4					96	Loose	
p.m.	4					98	Fair	
21 a.m.	4					96	Good	
p.m.	4					98	Fair	
22 a.m.	4					98	"	
p.m.	4					96	"	
23 a.m.	4	1–20	T-spoonful	.5 oz.		97	Good	
p.m.	4	1–20	"	.5 "		96	"	
24 a.m.	4	.1	"	.5 "		96	"	81 lbs.
p.m.	4	.1	"	.5 "		96	"	
25 a.m.	4	3–20	"	.5 "		98	"	
p.m.	4	3–20	"	.5 "		96	"	
26 a.m.	4	.2	"	.5 "		96	"	
p.m.	4	.2	"	.5 "		96	"	
27 a.m.	4	¼ or .25	"	.5 "		96	Fair	
p.m.	4					96	Loose	
28 a.m.	4					96	Fair	
p.m.	4					96	"	
29 a.m.						98	Good	
p.m.	4				1 oz.	96	"	
30 a.m.	4				2 "	96	"	
p.m.	4				2 "	96	"	
31 a.m.	4				3 "	85*	"	
p.m.	4					90	Very loose	
Sept. 1 a.m.	4					90	Fair	
p.m.	4				1 "	94	Good	
2 a.m.	4				1 "	90	"	
p.m.	4				2 "	96	"	
3 a.m.	4				2 "	89	"	
p.m.	4				3 "	96	"	
4 a.m.	4				3 "	96	"	
p.m.	4				4 "	96	"	
5 a.m.	4				4 "	96	"	
p.m.	4				5 '	93	Loose	
6 a.m.	4					96	"	
p.m.	4						Good	

Blood Meal did not prevent scouring, neither did salt, although it seemed to be of some benefit.

*Stove out of order.

IKE—Dropped June 7.

Date	Skim Milk	Molasses	Blood Meal	Condition	Weight
June 13 a.m.	3	3–20		Good	57 lbs.
p.m.	3	3–20		"	
14 a.m.	3	3–20		"	
p.m.	3	3–20		"	
15 a.m.	3	3–20		"	59.5
p.m.	3	3–20		Fair	
16 a.m.	3	3–20		"	
p.m.	3	3–20		"	
17 a.m.	3	3–20		"	
p.m.	3	3–20		"	
18 a.m.	4	3–20		Loose	
p.m.	4	3–20		"	
19 a.m.	4	.2		"	
p.m.	4	.2		"	
20 a.m.	4	.2		"	
p.m.	4	.2		"	
21 a.m.	4	.2		Fair	
p.m.	4	.2		"	
22 a.m.	4	.2		"	
p.m.	4	.2		"	62.5
23 a.m.	4	.2		Loose	
p.m.	4	.2		"	
24 a.m.	5	.2		"	
p.m.	5	.2		"	
25 a.m.	5	.2		"	
p.m.	5	.2	T-spoonful	"	
26 a.m.	5	.2	"	"	
p.m.	5	.2	"	"	
27 a.m.	5	.2	"	"	
p.m.	5	.2	"	"	
28 a.m.	5	.2	"	"	
p.m.	5	.2	"	"	
29 a.m.	5*	.2	"	"	67
p.m.	5	.2	"	"	
30 a.m.	5	.2 new	"	"	
p.m.	5	.2 "	"	"	

*Turned out in lot during day.

IKE—Continued.

Date		Skim Milk	Substances added		Condition	Weight
			New Molasses	Blood Meal		
July 1	a.m.	5	.2	T-spoonful	Loose	
	p.m.	5	.2	“	“	
2	a.m.	5	.2		“	
	p.m.	5	.2		“	
3	a.m.	5	.2		“	
	p.m.	5	.2		“	
4	a.m.	5	.2		“	
	p.m.	5	.2		“	
5	a.m.	5	.2		“	
	p.m.	5	.2		“	
6	a.m.	5	.2		“	67.5 lbs.
	p.m.	5	.2		“	
7	a.m.	5	.2		“	
	p.m.	5	.2		“	
8	a.m.	5			“	
	p.m.	5			“	
9	a m.	5			Better	
	p.m.	5			“	
10	a.m.	5			Loose	
	p.m.	5			“	
11	a.m.	Killed				

Blood Meal did not stop scouring; neither did exercise. Fresh molasses has the same effect as old molasses.

JOE—Dropped June 14.

From June 14 to 20 fed whole milk. June 20 and 21 fed skim milk.

Date	Skim Milk	Substance added	Condition	Weight
June 22 a m.	5		Fair	59.5 lbs.
p.m.	5		"	
23 a.m.	1.5	1.5 colostrum	"	
p.m.	2.5	2 "	Good	
24 a.m.	5		"	
p.m.	4		Loose	
25 a.m.	3	.5 c. c. formalin	"	
p.m.	4	.5 " "	"	
26 a.m.	4	.5 " "	"	
p.m.	4	.5 " "	"	
27 a.m.	3	1 oz. castor oil,	"	
p.m.	4.5	salol and bis. subnit.	"	
28 a.m.	4		Fair	
p.m.	4		Good	
29 a.m.	4.5		"	61
p.m.	4.5		"	
30 a.m.	4.5		"	
p.m.	4.5		"	
July 1 a.m.	4.5		"	
p.m.	4.5		"	
2 a.m.	5		"	
p.m.	5		"	
3 a.m.	5		"	
p.m.	5 pasteurized		"	
4 a.m.	* "		"	
p.m.			"	
5 a.m.	5		"	
p.m.	5		"	
6 a.m.	5		"	65.5
p.m.	5		"	
7 a.m.	5 raw		Fair	
p.m.	5		"	
8 a.m.	5		"	
p.m.	5		"	
9 a.m.	5		"	
p.m.	5		"	

*Turned out in lot during day.

JOE—Continued.

Date	Pasteurized Skim Milk	Substance added		Temp.	Condition	Weight
		Molasses	Blood Meal			
July 10 a.m.	3	1-20 boiled	T-spoonful	96	Fair	
p.m.	3	1-20 "	"	96	"	
11 a.m.	5	1-20 "	"	98	Good	
p.m.	5	1-20 "	"	99	"	
12 a.m.	5	1-20 "	"	97	"	
p.m.	5	1-20 "	"	94	"	
13 a.m.	5	1-20 "	"	98	"	67 lbs.
p.m.	5	1-20 "	"	96	"	
14 a.m.	3	1-20 "	'	99	Loose	
p.m.	4	1-20 "	"	95	"	
15 a.m.	5		"	94	"	
p.m.	5		"	99	"	
16 a.m.	3		"	98	"	
p.m.	4		"	96	"	
17 a.m.	4		"	96	"	
p.m.	4		"	99	Fair	
	Unpasteurized					
18 a.m.	4		"	98	Loose	
p.m.	4		"	98	"	
19 a.m.	4		"	98	"	
p.m.	4		"	96	Better	
20 a.m.	5		"	96	Good	68.5
p.m.	5		"	96	"	
21 a.m.	* 4		2 T-spoonfuls	96	Fair	
p.m.	5		"	96	Good	
22 a.m.	5		"	95	Fair	
p.m.	4		"	98	"	
23 a.m.	5		"	96	Good	
p.m.	5		"	96	"	
24 a.m.	5		"	96	"	
p.m.	5		"	96	Fair	
25 a.m.	5			98	"	
p.m.	5			96	"	
26 a.m.	5			96	"	
p.m.	5			96	Good	
27 a.m.	5			96	"	73.5
p.m.	5			96	"	
		Sugar				
28 a.m.	5	.5 oz.		98	"	
p.m.	5	.5 "		96	Fair	
29 a.m.	5	.5 "		95	"	
p.m.	5	.5 "		96	"	
30 a.m.	Not enough	skim sav'd			"	
p.m.	5	.5 oz.		96	Good	

*Kept in barn.

JOE—Continued.

Date	Skim Milk	Sugar	Temperature	Condition	Weight
July 31 a.m.	5	1 oz.	95	Fair	....
p.m.	5	1 "	96	Loose	....
Aug. 1 a.m.	5	....	96	Loose	....
p.m.	5	....	96	Fair	....
2 a.m.	5	....	98	"	....
p.m.	5	....	96	"	....
3 a.m.	5	....	96	"	73 lbs.
p.m.	Given	away			

This was never a very vigorous calf. Part of the time it was fed as a check on the rest of the calves. Pasteurization of milk, addition of blood meal and exercise had no noticeable effect either good or bad.

BOB—Dropped July 4.

Date	Milk		Temp.	Condition	Weight
	Whole	Skim			
July 6 a.m.	About 5 lbs.	Colostrum	....	Good	59.5 lbs.
p.m.	“	“	....	“	....
7 a.m.	“	“	....	“	....
p.m.	“	“	....	“	....
8 a.m.	“	“	....	“	....
p.m.	“	“	....	“	....
9 a.m.	5 lbs.	1 lb.	....	“	....
p.m.	5	1	....	“	....
10 a.m.	5	1	....	“	....
p.m.	5	1	....	“	....
11 a.m.	4	2	96	“	....
p.m.	4	2	94	“	....
12 a.m.	4	2	96	“	....
p.m.	4	2	96	“	....
13 a.m.	3	3	96	“	76
p.m.	3	3	96	“	....
14 a.m.	3	3	96	“	....
p.m.	3	3	96	“	....
15 a.m.	2	4	96	“	....
p.m.	2	4	98	“	....
16 a.m.	2	4	96	“	....
p.m.	2	4	96	“	....
17 a.m.	2	4	96	“	....
p. m.	2	4	98	Fair	....
18 a.m.	2	3	98	Loose	....
p.m.	2	4	97	Fair	....
19 a.m.	2	4	96	Good	....
p.m.	2	4	96	“	....
20 a.m.	....	4	97	“	77
p.m.	2	4	96	“	....
21 a.m.	2	4	96	“	....
p.m.	2	4	96	“	....
22 a.m.	1.5	4.5	97	“	....
p.m.	2	4	96	“	....
23 a.m.	2	3	96	Fair	....
p.m.	2	3	96	Good	....
24 a.m	1.5	3.5	96	“	....
p.m.	1	5	96	“	....
25 a.m.	2	4	96	“	....
p.m.	1	5	96	“	....
26 a.m.	1	5	96	“	....
p.m.	1	5	96	“	....

BOB—Continued.

Date	Skim Milk	Substances added			Temp.	Condition	Weight
		Sugar	Blood Meal				
July 27 a.m.	6				96	Good	81 lbs.
p.m.	6				96	"	
28 a.m.	6				96	"	
p.m.	6				96	"	
29 a.m.	6	.5 oz.			96	"	
p.m.	6	.5 oz.			96	"	
30 a.m.	6	.5 oz.			96	"	
p.m.	5				96	Loose	
31 a.m.	5				96	Fair	
p.m.	6				96	"	
Aug. 1 a.m.	5				96	Loose	
p.m.	5				98	"	
2 a.m.	5				98	"	
p.m.	4				96	"	
3 a.m.	4				96	Good	83.5
p.m.	4				96	"	
4 a.m.	4				96	Fair	
p.m.	4				96	"	
5 a.m.	4				96	"	
p.m.	4				97	Good	
6 a.m.	5				96	"	
p.m.	5				96	"	
7 a.m.	4		T-spoonful		96	Loose	
p.m.	5		"		96	"	
8 a.m.	4		"		96	"	
p.m.	4		"		96	"	
9 a.m.	3			1 oz. castor oil	96	"	
p.m.	1			Salol and Bis., subnit·	96	"	
10 a.m.	4		1		96	"	78.5
p.m.	was	not fed					
11 a.m.	4				96	"	
p.m.	4				96	"	
12 a.m.	4		4		96	"	
p.m.	4		4		98	"	
13 a.m.	4				96	"	
p.m.					-	"	
*14 a.m.	3				96	"	
p.m.	4			50 gr. Tannin	96	"	

*Kept in barn.

BOB—Continued.

Date	Skim Milk	Substance added			Salt	Temp.	Condition	Weight
		Molasses	Tannin	Blood Meal				
Aug. 15 a.m.	4	....	75gr.	....	....	96	Loose	....
p.m.	4	....	75 "	....	....	96	Better	....
16 a.m.	4	....	75 "	....	....	96	"	....
p.m.	4	1–20	75 "	....	....	96	Good	....
17 a.m.	4	.1	75 "	....	....	96	Loose	88 lbs.
p.m.	4	.1	75 "	....	....	96	"	....
18 a.m.	4	.1	100 "	....	....	98	"	....
p.m.	4	.1	100 "	....	....	98	"	....
19 a.m.	4	....	....	....	....	96	"	....
p.m.	4	....	....	....	....	98	"	....
20 a.m.	4	....	....	....	....	96	"	....
p.m.	4	....	....	....	....	96	"	....
21 a.m.	4	....	....	....	....	96	Fair	....
p.m.	4	....	....	....	....	96	"	....
22 a.m.	4	....	....	....	....	96	Loose	....
p.m.	4	....	....	....	....	98	Fair	....
23 a.m.	4	....	....	....	....	97	"	....
p.m.	4	....	....	....	....	96	"	....
24 a.m.	4	.1	....	T-spoonful	.5 oz.	96	Good	82
p.m.	4	.1	....	"	.5 "	96	"	....
25 a.m.	4	3–20	....	"	.5 "	98	"	....
p.m.	4	3–20	....	"	.5 "	96	Fair	....
26 a.m.	4	....	....	....	....	96	Loose	....
p.m.	4	....	....	....	....	96	"	....
27 a.m.	4	....	....	....	....	96	Fair	....
p.m.	4	....	....	....	....	96	Good	....
28 a.m.	4	....	....	....	....	96	Good	....
p.m.	4	....	....	....	....	98	"	....
29 a.m.	4	....	....	....	....	96	Fair	....
p.m.	Killed							

This was a very strong calf and was handled carefully. The change from whole to skim milk was made slowly. Up to the time sugar was added to the milk, this calf was in good condition. Tannin and salt probably had a slight tendency to stop the scouring.

MINNIE—Dropped July 10.

Date	Milk		Temperature	Condition	Weight
	Whole	Skim			
July 11 p.m.	3		95	Good	
12 a.m.	4.5		95	"	
p.m.	5		94	"	
13 a.m.	5		96	"	57.5 lbs
p.m.	4.5		96	"	
14 a.m.	4.5		99	"	
p.m.	4.5		97	"	
15 a.m.	4.5		96	"	
p.m.	5		96	"	
16 a.m.	3.5	1.5	96	"	
p.m	3.5	1.5	96	"	
17 a.m.	3	2	96	"	
p.m.	3	2	98	Fair	
18 a.m.	3	2	98	Loose	
p.m.	3	2	98	"	
19 a.m.	3		97	"	
p.m.	3		96	"	
20 a.m.				Better	57.5
p.m.	4		96	"	
21 a.m.	4		96	Good	
p.m.	4		96	"	
22 a.m.	4		96	"	
p.m.	3		96	"	
23 a.m.	3	1	96	"	
p.m.	3	1	96	"	
24 a.m.	3	1	96	"	
p.m.	3	1.5	96	"	
25 a.m.	3	2	99	"	
p.m.	3	2	96	"	
26 a.m.	2	3	96	"	
p.m.	2	3	96	"	
27 a.m.	2	3	96	"	62
p.m.	2	3	96	"	
28 a.m.	2	3	96	"	
p.m.	1.5	3.5	96	"	
29 a.m.	1	4	98	"	
p.m.	1	4	96	"	
30 a.m.	1	4	96	"	
p.m.	1	4	96	"	
31 a.m.	5		96	"	
p.m.	5		96	"	

MINNIE—Continued.

Date	Skim Milk	Substances added		Temper-ature	Condition	Weight
		Molasses	Blood Meal			
Aug. 1 a.m.	5			96	Good	
p.m.	5			96	"	
2 a.m.	5			96	"	
p.m.	3			96	Loose	
3 a.m.	4			96	Good	66 lbs.
p.m.	4			96	"	
4 a.m.	4			96	Fair	
p.m	4			96	"	
5 a.m.	4			96	"	
p.m.	4			97	"	
6 a.m.	4		T-spoonful	96	Loose	
p.m.	4		"	96	Fair	
7 a.m.	4		"	96	Good	
p.m.	4		"	97	"	
8 a.m.	4		"	96	Loose	
p.m.	3		"	96	"	
9 a.m.	4		"	96	Good	
p.m.	4		"	96	"	
10 a.m.	4		"	96	Fair	67.5
p.m.	4		"	96	"	
11 a.m.	4	1–20	"	96	Good	
p.m.	4	1–20	"	96	"	
12 a.m.	4		"	98	Loose	
p.m.	4		"	98	"	
13 a.m.	4			96	"	
p.m.	4			96	"	
14 a.m.	4*			96	"	
p. m.	4			98	"	
15 a.m.	4			96	"	
p.m.	4			96	Better	
16 a.m.	4			96	"	
p.m.	4			96	Fair	
17 a.m.	4			99	Loose	62.5
p.m.	4			97	"	
18 a.m.	4			96	"	
p.m.	4			98	Fair	
19 a.m.	4			96	Loose	
p.m.	4			98	"	
20 a.m.	4			98	"	
p.m.	4			98	"	
21 a.m.	4			96	"	
p.m.	4			96	"	

*Kept in barn.

MINNIE—Continued.

Date	Skim Milk	Substance added		Temp.	Condition	Weight
		Molasses	Tannin			
Aug. 22 a.m.	4			96	Loose	
p.m.	4			96	"	
23 a.m.	4			96	"	
p.m.	4			96	Fair	
24 a.m.	4			96	Loose	68.5 lbs.
p.m.	4			96	Fair	
25 a.m.	4			98	"	
p.m.	4	1–20	50. gr.	98	Good	
26 a.m.	4			96	Loose	
p.m.	4			96	Fair	
27 a.m.	4			96	"	
p.m.	4			96	Loose	
28 a.m.	4			96	"	
p.m.	4			96	Good	
29 a.m.				96	"	
p.m.	Taken off experiment					

This calf was fed very carefully as a check. It scoured when getting nothing but milk.

JIMMIE—Dropped July 21.

Date	Milk		Temperature	Condition	Weight
	Whole	Skim			
July 22 p.m.	4.5	Colostrum	96	Good	
23 a.m.	3	"	96	"	
p.m.	5	"	97	"	
24 a.m.	2	"	96	"	
p.m.	2	2	96	"	
25 a.m.	2	2	96	"	
p.m.	2	2	96	"	
26 a.m.	2	3	96	"	
p.m.	2	3	96	"	
27 a.m.	2	3	96	"	61.5 lbs.
p.m.	2	3	96	"	
28 a.m.	2	3	96	"	
p.m.	1.5	3.5	96	"	
29 a.m.	1	4	98	"	
p.m.	1	4	96	"	
30 a.m.	1	4	96	"	
p.m.	1	4	96	"	
31 a.m.		5	96	"	
p.m.		5	96	"	
Aug. 1 a.m.		3	96	Loose	
p.m.		3	96	Better	
2 a.m.		4	96	"	
p.m.		4	96	Good	
3 a.m.		5	96	"	65.5
p.m.		5	96	"	
4 a.m.		5	96	"	
p.m.		5	97	"	
5 a.m.		5	97	"	
p.m.		5	96	"	
6 a.m.		5	96	"	
p.m.		5	96	"	
7 a.m.		5	96	"	
p.m.		5	96	"	
8 a.m.		5	96	"	
p.m.		5	96	"	
9 a.m.		5	96	"	
p.m.		5	96	"	

JIMMIE—Continued.

Date	Skim Milk	Molasses	Tannin	Blood Meal	Salt	Temp.	Condition	Weight
Aug. 10 a.m.	5	1–20				96	Good	67 lbs.
p.m.	5	1–20				96	"	
11 a.m.	5	1–20	25 gr.			95	Loose	
p.m.	5	1–20	25 "			96	"	
12 a.m.	4	1–20	25 "			96	"	
p.m.	4	1–20	25 "			96	"	
13 a.m.	4					97	"	
p.m.	4					96	"	
14 a.m.	* 4					96	"	
p.m.	4			T-spoonful §		98	"	
15 a.m.	4			2 "		99	"	
p.m.	4			2 "		96	Better	
16 a.m.	4	1–20		2 "		97	Good	
p.m.	4	.1		2 "		96	"	
17 a.m.	4	3–20		2 "		96	Loose	64
p.m.	4	3–20		2 "		96	"	
18 a.m.	4	3–20	50 gr.			96	"	
p.m.	4	3–20	50 "			97	"	
19 a.m.	4					98	"	
p.m.	4					96	"	
20 a.m.	4					96	"	
p.m.	4					98	"	
21 a.m.	4					96	"	
p.m.	4					96	"	
22 a.m.	4					96	"	
p.m.	4					96	"	
23 a.m.	4					96	Fair	
p.m.	4					96	"	
24 a.m.	4					96	"	68
p.m.	4					96	"	
25 a.m.	4					98	"	
p.m.	4					96	"	
26 a.m.	4					96	"	
p.m.	4	1–20			.5 oz.	96	Good	
27 a.m.	4					96	Loose	
p.m.	4					96	"	
28 a.m.	4					96	"	
p.m.	4					96	Fair	
29 a.m.	4					96	"	
p.m.	Killed							

*Kept in barn.
§Better grade.
1–20 pound of molasses was sufficient to scour this calf.

HEIFER—Dropped March 12.

Date	Skim Milk	Substance added		Condition
		Sugar	Molasses	
July 15 p.m.	7.7 lbs.	4 oz.		Good
16 a.m.	8	4 “		Loose
p.m.	8	4 “		“
17 a.m.	8	4 “		Better
p.m.	8	4 “		“
18 a.m.	8	4 “		“
p.m.	8	4 “		Loose
19 a.m.	8	4 “		Better
p.m.	8	4 “		“
20 a.m.	8			Loose
p.m.	8			Good
21 a.m.	8			“
p.m.	8			“
22 a.m.	8			“
p.m.	8			“
23 a.m.	8		.4	“
p.m.	8		.4	Loose
24 a.m.	8			“
p m.	8			Good
25 a.m.	8	2 oz.		“
p.m.	8	2 “		“
26 a.m.	8	2 “		“
p.m.	8	2 “		“
27 a.m.	8	3 “		“
p.m.	8	3 “		“
28 a.m.	8	3.5 oz.		“
p.m.	8	3.5 “		Loose
29 a.m.	8	3 oz.		“
p.m.	8	3 “		“
30 a.m.	6.5			“
p.m.	8			Good
31 a.m.	8		.2	“
p.m.	8		.2	Loose
Aug. 1 a.m.	8		.2	Good
p.m.	8		Omitted	Loose
2 a.m.	8		.2	Good
p.m.	8		.2	“
3 a.m.	8		.3	Fair
p.m.	8		.3	“
4 a.m.	8			Loose
p.m.	8			Good
5 a.m.	8	3 oz.		Good
p.m.	8			Loose

HEIFER—Continued.

Date	Skim Milk	Substances added				Condition
		Molasses	Formalin	Tannin	Salt	
Aug. 6 a.m.	8	.3 lbs.				Good
p.m.	8	.3				Loose
7 a.m.	8					"
p.m.						Good
8 a.m.	8					"
p.m.	8					"
9 a.m.	8					Loose
p.m.	8					"
10 a.m.	6					"
p.m.	6					"
11 a.m.	4					"
p.m.	4					Fair
12 a.m.	6					Good
p.m.	6					"
13 a.m.	6					Fair
p.m.	6					"
14 a.m.	6					"
p.m.	6					"
15 a.m.	6					Good
p.m.	6	.1	1 c. c.			"
16 a.m.	6	.3	1 "			"
p.m.	6	.2	1 "			"
17 a.m.	6	.25	1 "			"
p.m.	6	.25	1 "			Loose
18 a.m.	6					"
a.m.	6					Good
19 a.m.	6					"
p.m.	6	.1		50 gr.		"
20 a.m.	6	.2		50 "		"
p.m.	6	.3		50 "		"
21 a.m.	6	.4		50 "		"
p.m.	6	.5		50 "		"
22 a.m.	6	.5		50 "		"
p.m.	6	.5		50 "		Fair
23 a.m.	6					Loose
p.m.	6					Fair
24 a.m.	6					Good
p.m.	6					"
25 a.m.	6					"
p.m.	6					"

HEIFER—Continued.

Date	Skim Milk	Substance added		Condition
		Molasses	Salt	
Aug. 26 a.m.	6			Good
p.m.	6			"
27 a.m.	6			"
p.m.	6	.2	1 oz.	
28 a.m.	6	.3	1 "	"
p.m.	6	.3	1 "	"
29 a.m.	6	.4	1 "	Fair—Would not drink
p.m.	6			Good
30 a.m.	6			"
p.m.	6			"

The milk was not warmed for this calf nor for any of the other older ones. Granulated sugar has a laxative effect the same as molasses. In sugar content 1-10 pound of "blackstrap" is equivalent to about one ounce sugar. 3 oz. sugar proved to be laxative, also 3-10 lb. molasses. Formalin 1 to 2700 parts milk was of no value. The addition of 50 gr. tannin enabled us to feed about twice as much molasses as before.

BULL—Dropped February 10.

Date	Skim Milk	Sugar	Substances added			Condition
			Molasses	Milk Sugar	Tannin	
Aug. 4 a.m.	6	2 oz.				Good
p.m.	6	2 "				"
5 a.m.	6	3 "				"
p.m.	6	3 "				Fair
6 a.m.	6	3.5 "				Good
p.m.	6	3.5 "				Loose
7 a.m.	6	4 "				Fair
p.m.	6	4 "				"
8 a.m.	6	4.5 "				"
p.m.	6	4.5 "				"
9 a.m.	6					Loose
p.m.	6					Good
10 a.m.	6		.2			"
p.m.	6		.2			"
11 a.m.	6		.3			"
p.m.	6		.3			Loose
12 a.m.	6	3 oz.				"
p.m.	6	3 "				"
13 a.m.	6					"
p.m.	6					Good
14 a.m.	6			2 oz.		"
p.m.	6			2 "		Fair
15 a.m.	6			3 "		Good
p.m.	6			4 "		"
16 a.m.	6			5 "		"
p.m.	6			7 "		Fair
17 a.m.	6			9 "		Good
p.m.	6					Very loose
18 a.m.	6					Fair
p.m.	6					Good
19 a.m.	6					"
p.m.	6		.1		50 gr.	"
20 a.m.	6		.2		50 "	"
p.m.	6		.3		50 "	"
21 a.m.	6		.4		50 "	"
p.m.	6		.5		50 "	"
22 a.m.	6		.5		50 "	Fair
p.m.	6		.5		50 "	"
23 a.m.	6					Loose
p.m.	6					Fair
24 a.m.	6					Good
p.m.	6					"
25 a.m.	6					"
p.m.	6					"
26 a.m.	6					"
p.m.	6					"

BULL—Continued.

Date	Skim Milk	Substances added			Condition
		Molasses	Salt	Lime Water	
Aug. 27 a m.	6				Good
p.m.	6	.2	1 oz.		"
28 a.m.	6	.3	1 "		"
p.m.	6				Loose
29 a.m.	6				Fair
p.m.	6	.2		.5 pint	Good
30 a.m.	6	.3		.5 "	"
p.m.	6	.3		.5 "	"
31 a.m.	6	.4		.5 "	"
p.m.	6				Very loose
Sept. 1 a.m.	6				Fair
p.m.	6				Good

.3 lbs. molasses and 3 oz. sugar proved to have the same effect. Tannin seems to have a beneficial effect. Lime water of no value. More of the milk sugar can be fed without scouring the calves than there can in case cane sugar is used.

BLACK—Dropped January 12.

Date	Skim Milk	Substances added				Condition
		Sugar	Molasses	Tannin	Milk Sugar	
Aug. 4 a.m.	6	2 oz.				Good
p.m.	6	2 "				"
5 a.m.	6	3 "				"
p.m.	6	3 "				Fair
6 a.m.	6	3.5 "				"
p.m.	6	3.5 "				Loose
7 a.m.	6	4				"
p.m.	6	4				"
8 a.m.	6					"
p.m.	6	4.5				Good
9 a.m.	6					Loose
p.m.	6					Good
10 a.m.	6		.2			"
p.m.	6		.2			Loose
11 a.m.	6		.2	25 gr.		"
p.m.	6		.2			"
12 a.m.	6	2				"
p.m.	6	2				"
13 a.m.	6					"
p.m.	6					Good
14 a.m.	6				2 oz.	"
p.m.	6				2 "	"
15 a.m.	6				3 "	Fair
p.m.	6				4 "	
16 a.m.	6				5 "	"
p.m.	6				7 "	"
17 a.m.	6				9 "	Loose
p.m.	6					Very loose
18 a.m.	6					Fair
p.m.	6					Good
19 a.m.	6					"
p.m.	6		.2	50 gr.		"
20 a.m.	6		.2	50 "		"
p.m.	6		.3	50 "		"
21 a.m.	6		.4	50 "		"
p m.	6		.5	50 "		"
22 a.m.	6		.5	50 "		"
p m.	6		.6	50 "		"

BLACK—Continued.

Date	Skim Milk	Molasses	Lime Water	Condition
Aug. 23 a.m.	6			Loose
p.m.	6			Fair
24 a.m.	6			Good
p.m.	6			"
25 a.m.	6			"
p.m.	6			"
26 a.m.	6			"
p.m.	6			"
27 a.m.	6			"
p.m.	6			"
28 a.m.	6			"
p.m.	6			"
29 a.m.	6			"
p.m.	6	.2	.5 pint	"
30 a.m.	6	.3	.5 "	"
p.m.	6	.3	.5 "	"
31 a.m.	6	.4	.5 "	"
p.m.	6			Very loose
Sept. 1 a.m.	6			Fair
p.m.	6			Good

.2 lbs. molasses and 2 oz. sugar each scoured the calf. Milk sugar not so laxative as cane sugar. Tannin has tendency to prevent scouring. Lime water valueless.

SPOT—Dropped January 15.

Date	Skim Milk	Substances added			Condition
		Sugar	Molasses	Tannin	
Aug. 4 a.m.	6	2 oz.	....	....	Good
p.m.	6	2 "	....	....	"
5 a.m.	6	3 "	....	....	Fair
p.m.	6	3 "	....	....	Good
6 a.m.	6	3.5 "	....	....	"
p.m.	6	3.5 "	....	....	"
7 a.m.	6	4 "	....	....	"
p.m.	6	4 "	....	....	"
8 a.m.	6	4.5 "	....	....	"
p.m.	6	4.5 "	....	....	"
9 a.m.	6	5 "	....	....	"
p.m.	6	5 "	....	....	"
10 a.m.	6	6 "	....	....	Fair
p.m.	6	6 "	....	....	"
11 a.m.	6	7 "	....	....	"
p.m.	6	7 "	....	....	"
12 a.m.	6	....	....	....	Loose
p.m.	6	....	....	....	"
13 a.m.	6	....	.2	....	Good
p.m.	6	....	.2	....	"
14 a.m.	6	....	.3	....	"
p.m.	6	....	.3	....	"
15 a.m.	6	....	.4	....	Fair
p.m.	6	....	.4	....	"
16 a.m.	6	....	.5	....	Good
p.m.	6	....	.5	....	"
17 a.m.	6	....	.6	....	"
p.m.	6	....	.6	....	Loose
18 a.m.	6	....	.7	....	Fair
p.m.	6	....	.7	....	"
19 a.m.	6	....	.7	....	"
p.m.	6	....	.8	50 gr.	Good

SPOT—Continued.

Date	Skim Milk	Substances added			Condition
		Sugar	Molasses	Tannin	
20 a.m.	6	....	.8	50 gr.	Loose
p.m.	6	....	.8	50 "	"
21 a.m.	6	....	.8	50 "	Fair
p.m.	Taken	off experi	ment	....	Loose

7 oz. sugar produced same effect as 0.8 lbs. molasses.

SPINGO—Dropped January 1.

Date	Skim Milk	Substances added			Condition
		Sugar	Molasses	Tannin	
Aug. 4 a.m.	6	2 oz.	......	......	Good
p.m.	6	2 "	......	......	"
5 a.m.	6	3 "	......	......	"
p.m.	6	3 "	......	......	ir
6 a.m.	6	3.5 "	......	......	"
p.m.	6	3.5 "	......	......	Loose
7 a.m.	6	4 "	......	......	Fair
p.m.	6	4 "	......	......	"
8 a.m.	6	4.5 "	......	......	"
p.m.	6	4.5 "	......	......	"
9 a m.	6	5 "	......	......	Good
p.m.	6	5 "	......	......	"
10 a.m.	6	6 "	......	......	Fair
p.m.	6	6 "	......	......	"
11 a.m.	6	......	......	......	Loose
p.m.	6	......	......	......	Good
12 a.m.	6	......	.2	......	"
p.m.	6	......	.2	......	"
13 a.m.	6	......	.3	......	"
p.m.	6	......	.3	......	"
14 a.m.	6	......	.4	......	Fair
p.m.	6	......	.4	......	Good
15 a.m	6	......	.5	......	"
p.m.	6	......	.5	......	"
16 a.m.	6	......	.6	......	Fair
p.m.	6	......	.6	......	"
17 a.m.	6	......	.7	......	"
p.m.	6	......	.7	......	Loose
18 a.m.	6	......	.7	......	Fair
p.m.	6	......	.7	......	Loose
19 a.m.	6	......	.7	50 gr.	Very loose
p.m.	6	......	.8	50 "	Good
20 a.m.	6	......	.8	50 "	Loose
p.m.	6	......	.8	50 "	"
21 a.m.	6	......	.8	50 "	Fair
p.m.	Taken off experiment			......	Loose

6 oz. sugar produced same effect as 0.7 lbs. molasses.

All milk was fed sweet and clean, and in the case of the young calves it was heated to a temperature between 95 and 100 degrees Fah. The feeding pails were sunned daily and the separator was scalded out every morning.

MILK SUBSTITUTE

—FOR—

CALF FEEDING

The following letter explains itself:

Hammond, La., April 20, 1908.

Dr. W. H. Dalrymple, Baton Rouge, La.

Dear Sir:—In compliance with your request I have visited the farm of Mr. J. A. Caston and obtained his method of raising calves on a milk substitute. It is as follows:

The calves are taken from their dams a day or two after birth and taught to drink from a pail. They are then given five to eight pounds of their mother's milk twice a day until the milk is fit for human use, which of course will vary with the different cows, but on the average Mr. Caston begins saving the milk on the fifth day after calving. The milk is then reduced until at the end of ten days the calf is receiving one pint of milk twice a day, and this amount of milk is fed until the calf is six weeks of age, when the milk is discontinued entirely. At the same time that the milk is being reduced, bean soup, shorts, blood meal and sometimes cottonseed meal are added to the calf's ration until at the end of ten days it is receiving twice daily, in addition to its pint of milk, bean soup from 4 oz. of navy beans, 3 oz. shorts, 1 oz. blood meal and probably about half the time 3 oz. of cottonseed meal. The calf receives this ration until it is six weeks of age, when the milk is discontinued and the same amount of the substitute fed as before until the calf is four months old, when it is weaned; that is, put on dry feed entirely. The calf is encouraged to eat hay as soon as it will. Mr. Caston prefers alfalfa to any other kind of hay, and peavine hay is his second choice. The calves run in an open lot and they have access to grass whenever there is any.

Mr. Caston thinks that failure in raising calves on bean soup is due more to the method in which the soup is prepared than to any other cause. Following is the method which he has found to be very successful: Parboil the beans in soda, then drain off the water and boil again until soft. Squeeze through a colander and add salt until the soup has a decidedly brackish taste. Stir in the shorts, blood meal and cottonseed meal and add lukewarm water until each calf receives about three quarts of the mixture. Of course the amounts to be given will vary with different calves. The above figures are the average for strong grade Holstein calves. The cost of the milk substitute is between 4 and 5 cents per day.

Very respectfully yours,

T. E. WOODWARD.

Louisiana Bulletin No. 105. April, 1908.

Agricultural Experiment Station

OF THE

Louisiana State University

and A. & M. College,

BATON ROUGE.

Diseases Affecting Rice

IN LOUISIANA.

H. R. FULTON, M. S.

BATON ROUGE:
THE DAILY STATE PUBLISHING COMPANY, STATE PRINTERS.
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Louisiana State University and A. & M. College

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DISEASES AFFECTING RICE IN LOUISIANA.

Four diseases of rice observed in Louisiana are here considered. They are blast, brown grain spot, green smut and black smut. The first named disease may affect leaf and straw, but its worst effects are upon the head; the remaining three affect the grains only. The first two may be expected to cause considerable loss any season, and are of major importance; the last two occasion little loss.

This report, which covers the work of one season and part of another, is merely a preliminary one. The purpose of it is to give some account of the nature of the several diseases mentioned, and to indicate the progress made in the study of them. A complete account of them, and definite conclusions regarding control measures must be deferred until more extended and detailed study has been made.

RICE BLAST.

GENERAL SYMPTOMS.

This disease is variously known as *blast, blight* and *rotten-neck*. It is, in all probability, the same as the disease of rice known in Italy as "brusone," and in Japan as "imotsi." Blast is caused by the attack of a particular species of fungus known as *Piricularia oryzae Bri. and Cav.* The most conspicuous lesions are found at the sheath-nodes just above the joints of the stem, at the region where the stem comes to be the axis of the head (the "neck" region), and at the points where the blades of the upper leaves join their sheaths. (Figs. 1 and 2.) The first indication of disease is apt to be a small, pale, somewhat watery spot; this increases in size, passing through shades of brown and finally becomes quite dark. The lesion extends more rapidly in an upward direction; at the neck it may involve as much as two inches of the axis, or it may completely encircle a sheath-node. In the later stages a nodal area frequently shows transverse fissures due to the contraction and cracking of the dead tissues. (Fig. 2.) At the junction of leaf-blade and leaf-sheath there is a breaking, as a result of which the blade hangs downward, it having given indication before this of its general unhealthy condition by a paling of color and drying. At the neck the diseased area is weak, and as the head becomes heavy in maturing, it gives way and the head hangs down or falls to the ground.

The more general effects of blast are seen in the extensive paling and drying of leaf and stem, and in the poor condition of the head. The worst effects on the head are seen when infection of the plant is early and the fungus is well established before the head shoots up from the last leaf-sheath. In such cases none of the grains fill out; and the erect heads with their light colored empty glumes can be distinguished at a distance. Such a condition caused by blast must not be confused with the "white blast" following the attack of the lavae of a moth which bore into the straw above the last node and cause the death of the head usually before flowering. The two conditions are somewhat similar in appearance, but are quite different in their nature.

If the attack of *Piricularia* at the neck is later and less severe, the head will fill out to a greater or less extent, but there will always be a considerable proportion of poorly formed grains —(Fig. 1). Many such heads will break at the weakened neck region while the rice is standing, and many others during harvesting. The circumstance that the heads that break are apt to be the heavier of the affected ones, makes this source of loss especially heavy. In threshing, much of the grain from affected heads is of such light weight as to be blown out in the cleaning. Because the damage caused by blast is apt to appear late, it is a frequent thing for the disease to occasion considerable miscalculation in regard to yield. Up to the heading period and even beyond it, indications may point to a good yield; and there is surprise and disappointment when the number of sacks turns out to be very many fewer than the expectation.

The destructive effects of the rice blast fungus may be seen at times upon quite young plants less than six inches high. The first indications of attack are brown spots which come to have ashy gray centers and involve the whole thickness of the leaf. These spots enlarge and coalesce until practically the entire leaf is involved. The lower and older leaves of the plant suffer first, and become entirely brown and dry and shriveled; afterward the younger leaves are destroyed, and the plant appears dead. But even in such severe cases a small percentage of the plants may have the closely wrapped bud portion unaffected, and under proper conditions may send up new shoots and continue growing. This blight of young rice seems to be infrequent, but it may be quite destructive when it does occur—(Fig. 3).

Spotting caused by *Piricularia* may occur on the leaves of plants almost or quite mature; but in such situations the effects are localized, and there is no such general dying as follows leaf infection of quite young plants.

THE BLAST FUNGUS.

If portions of stalk or leaf having affected areas be placed on a damp cloth and kept in a closely covered vessel for about a day, there can be detected covering the areas a delicate downy grayish growth. A similar appearance may be noted in the field when conditions are very moist. Under the microscope this grayish growth which is so readily formed on areas affected with blast, is seen to be composed of the minute fruiting-branches of the fungus known as *Piricularia oryzae.* These branches are apt to arise in clusters of a few; they are only slightly, if at all branched, and they produce at their extremities several spores which are shed in succession as they are formed—(Fig. 4). The spores are 24-28x10-12 in., oval, and larger at the attached end, where a slight protuberance can be seen. They are divided by two rather equally placed partition walls. When furnished with proper moisture these spores will germinate by the sending out of one or more thread-like germ-tubes which, under favorable conditions, will develop into the extensive mold-like mycelium of a new generation of the fungus. From this mycelium, fruiting-branches arise to produce a new crop of spores. This fungus grows quite well in the laboratory upon a variety of nutrient media, and by taking proper precautions a culture of it can be obtained entirely free from admixture of bacteria or other foreign organisms of any kind. Spores from such pure cultures when applied under proper conditions to parts of rice plants will produce discolored areas that have all the appearances characteristic of blast, and fruiting branches of *Piricularia* can be found in numbers in such areas. Infection takes place by the germ-tubes from the spores penetrating the tissues of the plant. Insofar as present knowledge goes, spread of blast infection in the field is accomplished solely by means of spores. Within the tissues the mycelium feeds upon the cells of the affected area, and finally causes their death. The consequent serious impairment of the functions of groups of cells at a sheath-node, at the base of a leaf blade, or along the stem just below the head, interferes with the proper supplying of nutriment to parts of the plant beyond, and there results naturally, though indirectly, deterioration in these parts, as it is apparent from the yellowing and drying of leaves and from the failure of grains to fill out properly.

A fungus that can not, it seems, be distinguished from the rice blast *Piricularia,* causes a blight of crab-grass, and may serve as a source of infection for rice.

INOCULATION EXPERIMENTS.

In these tests inoculation material of *Piricularia oryzae* was used in three forms: A, a suspension in sterile distilled water of macerated tissue from affected areas at the neck; B, a similar suspension of material from the neck region which had been kept in moist chamber until spore formation was abundant; C, a suspension in sterile distilled water of spores and some mycelium from pure cultures on steamed rice leaves.

The material was applied at the ligular region of the uppermost leaves of rice plants before the heads shot out from the enclosing sheaths, and application was made in such way as that a few drops might enter the sheath-cavities. In some instances the ligular region was pricked several times with a needle; in others care was taken that no injury of the tissues should occur. No attempt was made even to partially sterilize the areas inoculated. Vigorous plants were selected for the tests, and in every series an equal number of check plants were treated in every way similarly except that sterile water was applied instead of a suspension of fungus material. The rice plot used for the purpose was well isolated, and had only a trace of *Piricularia* infection in it during the time of the tests.

The percentages of infection resulting from the several inoculation tests are indicated below. Of the 150 check plants used only four developed *Piricularia* infection, and it has seemed unnecessary to record the percentages separately for these. The check plants were distributed irregularly among the inoculated ones. Counts were made after about ten days and eighteen days from inoculation.

		9-11 Days.	17-19 Days.
Inoculation material A.	No injury......	66 per cent.	83 per cent
Inoculation material B.	No injury......	66 ”	100 ”
Inoculation material B.	Pricked............	80 ”	100 ”
Inoculation material C.	No injury......	90 ”	100 ”
Inoculation material C.	Pricked............	100 ”	100 ”

In a series of 50 plants inoculated with material C upon uninjured tissues, evidence of infection was barely apparent on 50 per cent in five days; in nine days 80 per cent showed infection, and in thirteen days 94 per cent.

Successful inoculations were made on plants in various stages of growth, from six inches high to the flowering period. While the development locally of a well characterized lesion was made the test of infection, microscopic examination for the presence of *Piricularia oryzae* was frequently made as a check, and always in cases that seemed at all doubtful. Secondary effects—the dying of leaves and the failure of heads to fill out properly—were repeatedly seen in the artifically induced attacks of blast. Neck infection usually followed inoculation of the ligular region of the uppermost leaf while the head was still in barrel.

An abundance of *Piricularia grisea* on crab-grass (*Panicum sanguinale* Linn.) gave opportunity to compare to some extent this species with *Piricularia oryzae*. The mode of growth and the microscopic appearances of each fungus were observed in pure cultures grown on a number of different media. It did not seem possible to distinguish the two forms on the basis of morphological characters. Infection of young rice plants was secured under controlled conditions by the use of spores from a culture of the crab grass fungus. Further comparison of physiological characteristics was not attempted. The writer's rice material agreed with authentic specimens of *Piricularia oryzae,* and his crab-grass material with accepted specimens of *Piricularia grisea.**

The inoculation tests, insofar as they go, confirm the conclusion of Haven Metcalf (Science, n. s. XXV, p. 264) regarding the causative role of *Piricularia oryzae* in relation to the blast of rice; and of R. Farneti (Riv. Patol. Veg., II., pp. 1-11, 17-42) regarding the seeming identity of *Piricularia oryzae* and *Piricularia grisea.* In Japan the investigations of T. Kawakami led to the same conclusions. (Abstract in Experiment Station Record, XIV, p. 877.)

OCCURRENCE AND CONDITIONS FAVORING SPREAD.

The prevalence of the fungus causing rice blast depends seemingly upon a number of factors about which our knowledge is as yet far from complete. While a small amount of blast can be found probably every season in any locality where rice is grown extensively, severe outbreaks characteristically occur during particular seasons and in particular localities.

Weather conditions seem to have something to do with the spread of blast. Excessive humidity does not seem to be conductive to extensive epidemics, nor is this condition a necessary one. That other factors more local in effect are concerned, is indicated by the frequently observed fact that certain fields may be more severely affected than adjoining ones. The writer has discussed the matter with a number of rice growers; and their various suppositions and beliefs include almost every conceivable condition affecting the rice from seed time to harvest, and are sometimes most contradictory. Perhaps the most that can be gotten from it all is that when all conditions favor the best growth of the rice plant, more especially, perhaps, at the rather critical period of heading up, there will be the least chance of invasion by the blast fungus; any condition or set of conditions less favorable may predispose the plant to blast attack.

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*The writer expresses his appreciation of the courtesy of Mrs. Flora W. Patterson, of the Bureau of Plant Industry, in making the comparisions.

From his study of rice blast in South Carolina, Haven Metcalf (South Carolina Agricultural Experiment Station Bulletin 121) was led to conclude that soil conditions have much to do with the occurrence of blast. It was observed that blast was most severe on land rested under water on alternate years, on newly reclaimed land, and on land fertilized with nitrogenous manures. In Louisiana the writer has seen some striking cases of blast infection on land newly planted in rice; the worst affected fields he has seen have been of this kind. On the other hand the majority of rested tracts that have come under his observation have not showed unusual degrees of blast infection; and blast has been found quite serious on tracts continuously planted in rice and not fertilized with nitrogenous material. It is to be noted that the rested lands mentioned above had in all cases been in sod or in dry cultivation, and not under water as seems to be the practice in South Carolina.

At Crowley, La., where certain fertilizing experiments have been carried on with rice by this station in co-operation with the Bureau of Plant Industry, there was a small amount of blast infection throughout the field in September, 1907. Careful observation showed it to be quite evenly distributed over the sixty or more plots of the experiment; and in the case of those plots showing extremes of infection, no connection could be established between the use of nitrogenous materials as fertilizer and a tendency to increase of blast.

Certain Italian investigators emphasize the matter of the improper aeration of the roots of the rice plant in connection with the diseased condition denominated by them brusone, and probably identical with our blast. Some of these investigators hold that lack of proper root aeration is the real cause of brusone, and that the presence of *Piricularia oryzae* is a secondary phenomenon. While the writer can not believe that this is the cause of blast as he has seen it, he recognizes that poor aeration may be a predisposing cause which contributes largely to the spread of the disease at times.

In the whole matter of the factors concerned in the spread of blast, no accurate conclusions can be drawn, it seems, except from careful observations extending over a number of seasons, and made in a number of localities. It is altogether probable that when the factors which determine the occurrence of *Piricularia* in severe outbreaks are thoroughly understood, they will be found to be such as can be controlled satisfactorily in agricultural practice.

In Louisiana blast prevails in the race fields along the lower Mississippi river and in those of the southwestern part of the State. It seems with some exceptions to occasion insignificant loss in the river district, perhaps because of the earliness and the rapidness of the harvesting. In southwestern Louisiana severe outbreaks are local, but the loss in the affected district may be considerable, from 5 per cent to 25 per cent of the yield.

PREVENTIVE MEASURES.

1. In the South Carolina experiments it was found that spraying with Bordeaux mixture while the heads are still in barrel prevented serious damage from blast. Unfortunately the spraying of rice at such a stage is not a practicable measure. It is interesting to note that this treatment has been recommended for brusone in Italy; the efficacy of it would tend to support the contention that brusone is due primarily to the attacks of a parasitic organism rather than to a condition of the root system.

2. In the Carolina experiments it was found that applications of lime to the soil reduced blast and greatly increased yields. While this treatment seemed at first quite promising, further tests under a wider range of conditions have not been altogether satisfactory, and lime is not to be recommended as a general preventive of blast.

3. The idea has prevailed in some quarters that the withdrawal of water at the time of heading up will prevent blast. Insofar as the writer has been able to learn the experience of rice

growers in this matter, the evidence is rather conflicting. As has been indicated already, the whole matter of the treatment of rice at about this period, and for that matter at all periods, ought to have careful study with the purpose of determining the relation to the spread of blast.

4. Immune varieties. It is of interest to know that the variety of rice known as "bertone" in Italy was, at the time of its introduction into that country in 1828, almost if not absolutely immune to brusone. But in the years that have followed bertone rice has lost to a great extent its resisting powers, and at the same time there has been marked general deterioration in the variety. Nevertheless this gives indication that it may be possible to discover or to originate varieties of rice having satisfactory resistance to blast. Proper care ought to maintain the excellence of such varieties. Work along this line has recently been undertaken by Dr. Haven Metcalf of the Department of Agriculture.

The writer examined the variety plots of rice at Crowley, La., in the latter part of September, 1907, at which time the earliest varieties had been harvested, and the latest varieties had not reached the barrel stage. Observations could be made on 136 varieties. All of these showed blast, but in widely varying amounts. Several varieties were infested to the extent of 95-100 per cent. The least affected varieties were practically free from it, but on close scrutiny showed a few blasted stalks. There was such a small amount of blast on ordinary Honduras and Japan rice in the same field, that it could not be determined that any of these foreign varieties are probably less susceptible than the domestic varieties.

It seems that of the common varieties, red rice is the most susceptible, short-stemmed Japan (Kiushu) next, and Honduras least; but there is not a great difference, and it may be that Japan shows worse effects from blast merely because of its lateness and the progressive increase in amount of infective material during the season. The observations of the writer on long-stemmed Japan (Shinrika) have not been extensive, but it seems to be affected to about the same degree as ordinary Japan.

5. Early maturing of rice. The fact that blast seems not to affect rice to a serious extent until mid-season or later, or at least that losses are much greater at a later than an earlier period, would indicate that the early maturing of rice might to some extent avoid loss from blast.

6. The destruction of stubble and trash by burning over the fields, which is practiced by many planters, probably does much to reduce the amount of infectious material and to prevent a severe outbreak the following year. While the exact means of surviving the winter has not been determined for the blast fungus, it is likely some spore form which would be destroyed in large measure by burning over fields that may have been badly infested with blast.

BROWN SPOT OF RICE GRAINS.

DESCRIPTION.

The terms *speck* and *pip* are also applied to this condition of the rice grains. It is characterized by the presence of one or more very evident discolored and perhaps shrunken areas. Typical spots are rather regularly circular and have a diameter of 1-16 to 1-8 of an inch; they are bounded by a dark marginal line. The general enclosed area is grayish or very pale buff, and may show at the center a minute dark spot. In other cases there is marked shriveling and distortion which may involve the entire grain or only a portion of it; and the affected area is of irregular shape, and does not always show the dark bounding line. Such an area may be rather dark throughout its extent, or it may show merely the lighter discoloration—(Fig. 5).

The interior portion of a grain under a spot is chalky, quite opaque, and brittle, and the whole grain is of inferior quality. Such grains break in the milling, and indications of the spots are apt to remain after the completion of the process. On this account rice that is spotted commands a low price. Extremely bad samples may have practically every grain spotted; and in localities where spot prevails it is not unusual for ten to twenty-five per cent of the grains to be affected.

THE CAUSE.

Careful examination shows that the discoloration and general abnormal condition of the tissue are immediately caused by the growth in the spotted areas of several kinds of bacteria and fungi—(Figs. 6 and 7). Usually in a given spot one particular species of organism is found. All the species observed have the faculty of living saprophytically upon a wide range of nutrient media, and there is no evidence that they have anything of a parasitic relation to the developing rice grains. They can, however, grow well upon the food material contained in the grains, just as they might upon similar material in almost any situation. Their inroads upon the grain contents give rise to the abnormalities which become externally apparent. Of the fungi obtained in culture from the spots, a species of *Fusarium*, a species of *Mascrosporium,* and an amerosporic species of undetermined relations, were the ones most frequently met with.

An examination of suitable spots, usually rather young ones, shows in the center of each a minute depression such as might have been caused by a prick with a very fine needle. The hull just over such a place shows, especially when the inner surface is inspected, a corresponding puncture.

In the field several species of insects belonging to the Pentatomidae, or stink-bug family, can be seen to puncture grains in young stages and to suck food from them. The species that is by far the most usual one, is known technically as *Oebalus pugnax* Fabr.; two others of considerably less prominence are *Euschistus tristigmus* Say, and *Proxyx punctulatus* Pal. Beauv.* *Oebalus pugnax* is brown, 1-2 inch or a little less in length and 3-16 broad; its general outline may be described as coffin-shaped. Posteriorly thin portions of the wings are exposed—(Fig. 5). The other two species named are larger and heavier, and are colored dull green and black respectively. *Oebalus* seems to be the only one that causes considerable damage. Late in the season in certain years and in certain localities this species may be so abundant as to puncture practically every unhardened grain in the rice fields.

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*The writer expresses his appreciation of the courtesy of Dr. L. O. Howard, of the Bureau of Entomology, in determining the insect species.

That the punctures of these insects may be followed by the growth within the grains of bacteria and fungi which cause the spots, can be definitely shown by enclosing insects and uninjured heads of growing rice under bags. When six *Oebalus* individuals were kept for ten days on a large head that was in the milk stage at the outset, all the grains developed spots, the average number being about five per grain; grains attacked under natural conditions usually show one spot each. Heads that were similarly covered with cloth, under which no insects were placed, showed no spotting of the grains. Like results were repeatedly obtained with the three species of insects named.

Field observations during two seasons have showed that where the diamond-backed *Oebalus* was abundant, grain spot was conspicuous, and where the insect did not occur, spot could not be detected. Mill men state that Japan rice is worse affected with brown spot than Honduras. This is doubtless because the former matures late in the season when the bugs are most numerous. Seasonal and local variations in the numbers of the bug seem to be great, and the determination of the causes that are responsible for the fluctuation in numbers will probably be found to have an important bearing in the matter of control.

That other punctures than those made by insects may afford entrance for the spot-producing bacteria and fungi, was determined by puncturing immature grains in the field with a very fine needle. These developed spots in every way similar to the ones following insect punctures. In other tests the attempt was made to reduce the chance of infection by sterilizing the glumes externally insofar as might be, by flaming the needle before each puncture, and by protecting the heads operated upon in sterilized glass chambers. When these precautions were taken, only a small proportion of the grains developed spots at the points of puncture. It is reasonable to believe that none would have been so affected if perfect sterilization could have been carried out under these rather difficult conditions.

Altogether the evidence seems sufficient for the conclusion that the spots are caused immediately by the growth of saprophytic organisms within the rice grains, and that these organisms gain entrance through the punctures made by sucking insects, being either introduced at the time of puncturing, or later finding lodgment by chance at the point of puncture.

EFFECTS ON THE GRAINS.

When attacks were made upon grains in the very early milk stage, extensive shriveling and distortion followed as a rule; when older and firmer grains were punctured the lesions were apt to be of the more circumscribed and regular type. Fungi were more often found associated with the shriveled spots; bacteria with the regular ones—(Figs. 6 and 7.) Unless the grains were punctured quite often in a very young stage, the amount of material extracted by the insect did not seem to be great enough to distort the grain.

The unfitness of spotted grains for milling has been referred to. If they happen to come out whole, their chalkiness, or the remnant of the spot that is very likely to remain, detracts from the value of the finished rice in which they are found.

The effect of spotting on the germinating powers of rice is marked. A test was made by selecting from a lot of seed rice several hundred spotted grains, and comparing their percentage of germination with an equal number of sound grains from the same lot. The spotted grains gave 45 per cent, the sound grains 98 per cent of germination.

NOTES ON THE INSECTS.

Under the title ''Oebalus pugnax an enemy of grasses,'' H. Garman (Psyche VI., p. 61) reports that in Kentucky, where this species is common, he found it attacking millet and grasses of the genera *Setaria* and *Panicum.* The young spikelets were punctured and emptied of their contents; and they afterwards dried.

In the Fourth Report of the United States Entomological Commission, C. V. Riley reports that both *Oebalus pugnax* and *Proxyx punctulatus* are destructive of cotton worms from which they suck the juices by means of their short beaks. And W. H. Ashmead has reported (Insect Life, VII., p. 320) from Mississippi that *Proxyx punctulatus* feeds on the sap of the cotton plant. Observations in the rice fields have not suggested anything else than an exclusively vegetable diet for the insects named. The whole period of development of *Oebalus pugnax* seems to be rather short, probably not longer than two weeks. Eggs deposited under the bags in the course of the experiments hatched quickly, and the young grew rapidly. When about three quarters grown they could be seen puncturing young grains. There can be a large number of generations in a season. About twelve eggs are deposited in two straight rows, the eggs of one row alternating with those of the other. The eggs are pale green, kettle-shaped with a flat upper or lid portion, and quite small. They are attached to the straw or leaves of rice, or to some other convenient object.

CONTROL.

Where these insects are numerous the damage to rice occasioned by their punctures is always great; and the prevention of this damage would be well worth the going to considerable trouble and expense. The insects do not seem to become serious pests until their numbers become quite large, and this is not until late in the season. They ought to be most easily fought early in the season. During this time it is likely that they feed on wild grasses that head up early, or perhaps on other plants. A definite knowledge of their feeding habits would probably show preferences that could be made the basis of a successful mode of trapping them.

The fact that their occurrence in large numbers is only in particular localities and during particular seasons, suggests that the natural causes that hold them in check at other times and in other places, may be discovered and used against them.

A detailed study of the life histories of these insects, especially of *Oebalus pugnax,* is of much importance.

GREEN SMUT.

DESCRIPTION.

This disease usually affects one or only a few grains in a head. These become enlarged, more in width than in length, so that the resulting mass is spherical and one fourth inch or more in diameter—(Fig. 10). Externally a dark green powdery layer gives a characteristic appearance to the affected grains; but sometimes the yellow color of an earlier formed and underlying layer is apparent. The enlarged grains project from between the glumes which are now spread wide apart. When a grain is cut across, it is seen that the greater part of the central portion is a compact white mass; bounding this is the rather narrow brownish-yellow zone; and superficially is the powdery dark green layer. Remnants of the broken cuticle of the grain can sometimes be seen near the glumes; otherwise nothing is left of the rice grain tissue.

This peculiar enlargement of rice grains is due to the growth within them of a fungus that bears a superficial resemblance to some of the smut fungi which commonly attack cereals of various kinds. The dense central white portion is composed of the hyphae or threads of the fungus, closely woven together and forming the kind of compact body known as a sclerotium. Superficially the threads produce minute spores in very large numbers —(Fig 8); these are at first clear, but gradually become yellowish and finally olive green.

THE FUNGUS.

The hyphae of the central portion of the sclerotial mass are closely interwoven and divided into short, rather thick-walled cells, forming such a pseudoparenchymatous tissue as is found in many sclerotia. Towards the periphery the threads have a parallel and radial course, and the tissue loses its cellular character. In this region, which is the yellowish peripheral one already mentioned, there are formed along the sides of the hyphae the spores which are closely and irregularly disposed, and seem to be borne directly upon the hyphal walls. The spores are spherical, and in early stages are smooth-walled and hyaline changing to yellow. Farther out are the fully formed spores which are spherical, 4 to 6 mu. in diameter, with a rather thick spore wall covered with wart-like projections. In mass the mature spores are dark olive green; when viewed singly this color is rather dilute.

When placed in distilled water or in a nutrient solution, the spores germinated with about equal frequency, but never more abundantly than about 10 per cent. Germination was best in the case of new spores, and remained good for several weeks. There was a gradual deterioration, and at the end of six months, and again at the end of a year, efforts to secure germination were unsuccessful.

In distilled water germination took place by an irregular breaking of the spore wall, and the emission of a rather fine hyphal branch—(Fig. 9, a). This remained comparatively short, usually not more than twice the spore diameter, and enlarged terminally to produce a single oval, hyaline secondary spore smaller than the original; this may be termed a sporidium. Later, in some cases, a short branch would arise from just below the attachment of the sporidium and produce at its end in a similar way a second sporidium.

In ordinary beef nutrient solution the germ hypha was usually longer, and several rather than one or two sporidia were formed—(Fig. 9, b). When the medium was slightly acidified the germ hyphae developed into an extensively branched and septate mycelium which produced terminal elongated clusters of sporidia. These were formed by the successive growth of sporidium-bearing branches from just below the last formed sporidium in each case, the development being that of a scorpioid cyme—(Fig. 9, c).

The sporidia were seen to germinate occasionally, and only in dilute acidified solutions of cane sugar. They became swollen and lost their contents; their germination resembled closely that of the conidia, but the germ hyphae were usually shorter and the new sporidia slightly smaller—(Fig. 9, d). No germination in turn of these last was seen.

The germ hyphae from the dark spores on account of their extensive growth, branching habit, and septate condition, suggested the vegetative mycelium arising from the conidia of fungi, generally rather than the promycelium of a smut fungus. Attempts to induce this mycelium to continue its growth and develop into a sclerotial mass, were not successful. Naturally formed sclerotia kept for seven months in moist sand and in earth did not show indications of the production of ascus-bearing fruit bodies.

This fungus of the rice, which bears a superficial resemblance to certain of the smut fungi, was described and figured by Patouillard (Bull. de la Soc. mycol., 1887, p. 124) who gave it the name *Tilletia oryzae*. Later O. Brefeld (unters. a. d. Gesam. d. Mykol., XII., 194-202, and Bot. Centrbl., LXV., 97-108) made a very thorough study of the germination of the spores, of the formation of sclerotia by the mycelium arising from them, of the formation of spores in turn by these sclerotia. He also studied a very similar fungus which attacks the grains of the grass *Setaria Crus-Ardeae*. The sclerotia of this last were induced to form apothecia with asci and distinctive ascospores. On account of the similarity of the known stages of the rice fungus to the *Setaria* fungus, and on account of the perfect stage of the latter, Brefeld was led to include the two in his new genus *Ustilaginoidea*, and to propose the name *Ustilaginoidea oryzae* for the rice fungus. He regards the genus as having relationships with the Ascomycetes, and more especially with some forms of the Hypocreaceae, rather than with the Hemibasidii. The dark smut-like spores are regarded as true conidia. The name at present accepted for the rice fungus is *Ustilaginoidea virens* (Cke.) Tak.

OCCURRENCE IN LOUISIANA.

The green smut of rice has existed in Louisiana, according to the statements of rice planters, for quite a while, certainly eight or ten years. At present a small amount can be found in almost every large area of rice, and sometimes it is abundant enough to be quite obvious. As a general thing it merely excites the curiosity of the planter, and does not occasion any concern. In the worst cases that have come under observation, probably one head in four or five hundred was affected, and one or only a few grains of each head destroyed; the rest of the head would be perfectly normal. The smut balls are of such large size as to be removed in the threshing, and on this account do not cause trouble in milling.

In Japan, where the fungus has been under observation for a long time, it is said not to cause much damage, although at times thirty or more grains on a single head may be affected.

In Louisiana *Ustilaginoidea virens* has been found on Honduras and on red rice, and very infrequently on long-stemmed and on short-stemmed Japan rice.

MODE OF INFECTION.

The question of the mode of infection of rice by *Ustilaginoidea* is a rather complicated one. The fungus is one the life history and relationships of which are imperfectly known. The general resemblance of the dark spores to those of certain of the smuts, at first suggests that infection may take place in some one of the several ways known for this group. Of these, infection through the first leaf-sheath of the very young seedling, and infection of the pistil at the time of flowering, seem to be the possible ways in the present case.

Two kinds of spores, dark conidia and the sporidia formed at their germination, are known for the rice fungus; and analogy with the *Ustilaginoidea* affecting *Setaria* suggests the possibility of a third kind, ascospores. The conidia produce mycelium, and according to Brefeld this is capable of indefinite growth and the production of sclerotial masses which in turn form conidia. One would think that development would take place equally as well in the proper host plant as in an artificial medium, and that the mycelium from a conidium might be the means of infection of the rice plant. The secondary spores, or sporidia, which are regarded by Brefeld as rudimentary and functionless, have been observed by the writer to be invariably formed on mycelium from a conidium after a more or less extensive, but never indefinitely great growth of this mycelium; furthermore these sporidia have been observed to sprout in a definite way. This gives some basis for the supposition that they may not be functionless, but may serve as agents of infection.

In the case of the *Setaria* fungus, Brefeld found that the ascospores on germination produced sporidia in exactly the same way as the conidia did, and that these sporidia in turn germinated by forming secondary sporidia and also mycelium, which last branched into a rich vegetative growth. This would indicate that in the case of *Setaria* at least the sporidia developed from ascospores, which sporidia are entirely like those from conidia in appearance, are functional and probably serve to produce infection.

To test the matter of seedling infection in the case of rice, grains for planting, from some of which the glumes had been removed, were treated for ten minutes with water at 132 F., and on the following day were moistened and so thoroughly covered with *Ustilaginoidea* spores that the exterior had a greenish cast. In this condition the seed was planted in fresh ground. About two hundred plants reached maturity; there was no indication of green smut on any of them.

Grains were sprouted between filter paper on which *Ustilaginoidea* spores, spores observed to be forming sporidia, were thickly spread. Careful examination of serial sections from thirty-five such seedlings did not show any suspicious mycelium. Freehand sections of many others gave similar negative results.

Grains that had been thickly covered with spores, were sprouted in sterilized soil; out of a large number examined none showed mycelium.

The circumstance that the germination of the conidia becomes markedly less vigorous in the lapse of time, and that no germination can be secured after six months or thereabouts, would have weight against the theory of infection of seedlings by conidia or by sporidia produced from conidia.

The odds would be overwhelmingly against the chance of ascospores that might be produced by the rice fungus coming in contact with a germinating rice seed; and the possibility of seedling infection through the agency of ascospores may be dismissed summarily.

When it becomes a question of flower infection, three possibilities present themselves. The first is that infection may be spread from flower to flower by conidia or the sporidia produced by them; and the mycelium may remain dormant in the rice grain, resuming growth when the grain sprouts and keeping pace with the growing plant in its young tissues, until finally it develops a sclerotial mass and dark spores at the heading of the plant a year after the infection of the flower. If this occurs, it would be expected that many or all grains of a head, and that more than one head of a stool, would show effects. Out of a certain lot of affected heads taken at random, 55 had one grain affected, 10 had two grains, 6 had three grains, and 2 had five grains. The matter of stool infection has been kept in mind in the field observations. The instances of there being more than one head of a stool affected have been so few as to lead one to regard them as mere chance occurrences.

In order to test directly this mode of flower infection, rice flowers were treated in 1907 with green smut spores, both dry and suspended in water; the seed from these will be planted in 1908. An imperfect test was made during the season by planting the sound seed from affected heads of the 1906 crop. The results were negative. But when it is remembered that affected grains are borne with striking frequency on the lowermost spikelets which bloom after the grains of practically the entire head have set, and further that in any case the time required for the development of the spore mass is such that flowering of particular head would be over when the spores reach maturity, it will be perceived that the seed of an affected head have no specially good chance to become infected.

The second possibility in the way of flower infection, is that the mycelium from a conidium or sclerotium grows vigorously upon entrance, and forms the sclerotial mass and spores within a few days. Such being the case, some special means for carrying the fungus over to the next season would have to exist. The sclerotial mass may serve this purpose, as the similar one does in the case of the species of *Ustilaginoidea* on *Setaria.*

If formation of the smut balls follow infection immediately, it would be expected that affected heads would as likely occur in different stools as in the same stool, and that not many grains of a head would be affected. This is the case. It would further be expected that infection early in the season would be slight and localized, and that it would become progressively greater and more widespread with the lapse of time. In the field the localized character of the infection when small in amount, was often strikingly shown. It was frequently the case that one would walk for several hundred yards through a field without seeing a smutted head, and would then find several within a radius of a few feet. It has not been possible for the writer to observe suitable tracts continuously enough to make a statement regarding progressive spread during the season. Certainly smutted heads do not become prominent in a locality until harvesting is well under way. Dr. S. Hori, of the Imperial Agricultural Experiment Station of Japan, whose observations of this smut have extended over many years, states that it developes abundantly during the flowering time of the rice plant, especially in rainy weather.

To test directly immediate flower infection by conidia, several thousand rice flowers were treated during the brief period of their opening with spores of the green smut. The spores used were of the preceding year (1906), and also, as soon as they could be obtained, of the immediate year. They were inserted within the glumes dry by means of a brush, and they were in other cases sprayed with a suspension of spores in water, in some instances germinating conidia with sporidia were used. The seed matured quite normally, and there was no formation of smut balls.

A third possibility is that infection of flowering rice may be caused by sporidia from ascospores developed by sclerotia that have remained on the ground since the previous year, as was assumed in the preceding case, and that no other infection takes place, the conidia and the sporidia from conidia being functionless.

It will be readily appreciated from what has been said that there is not sufficient evidence at hand for conclusions to be definitely drawn regarding the mode of infection of rice by green smut. Theoretical considerations may play a part in the ultimate solution of the question by suggesting lines that rigid experimentation should follow.

MEANS OF PREVENTION.

Until something is known more definitely about the mode of infection, very little can be said about the prevention of green smut. Fortunately at this time in Louisiana there seems to be no necessity for saying anything about the matter, because of the insignificant damage done by the disease.

It was thought advisable to test in the case of rice the effects of the standard fungicidal seed treatments for grains

It was found that the germination of seed rice was not appreciably affected by the following treatments: Formalin, 1:400, 20 mins., and 1:100, 20 mins.; copper sulphate, 1:200, 24 hrs., followed by lime water; bichloride of mercury, 1:800, 20 mins.;

sar solution (U. S. Dept. of Agr. Farmers' Bulletin 250), 1:200, 2 hrs.; potassium sulphide, 1:100 20 mins.; hot water, 132° F., 10 mins., and 140° F., 5 mins.

When copper sulphate was used without being followed by the lime, germination was somewhat below normal.

Spores of *Ustilaginoidea virens* were subjected to similar treatments. In the case of the solutions of chemicals, the spores, after exposure, were transferred with as little of the fluid as possible to large quantities of water. That the small amounts of chemical substances unavoidably carried over did not influence results was determined at the end of each test by adding fresh spores of the same lot to the water used for germination; these fresh spores germinated normally. The following treatments killed the spores subjected to them: Formalin, 1:400, 20 mins., 1:1000, 20 mins.; copper sulphate, 1:200, 20 hrs., 1:2000, 20 hrs.; bichloride of mercury, 1:800, 20 mins.; sar, 1:200, 20 mins.; potassium sulphide, 1:100, 20 mins., 1:200, 20 mins.; hot water, 132° F., 10 mins., 130° F., 5 mins.

The conclusions are that the modes of seed treatment ordinarily used for the prevention of certain cereal smuts can be applied to rice, and that the dark conidia of *Ustilaginoidea virens* are killed by such treatments. It must be borne in mind, however, that these spores are not known to infect rice in the seedling stage, and that in general seed treatment for the prevention of smut is useful only when infection takes place in this particular way.

BLACK SMUT.

DESCRIPTION.

The interior of an affected grain is filled with a dry black powder which is enclosed for a time in the grayish outer membrane or cuticle. Often there is a slight enlargement of the grain, and the glumes are separated a little so that a portion of the affected kernel is exposed to view; but sometimes the grain is not enlarged—(Fig. 10, a.) When ripe, the thin dry enclosing membrane is readily broken, and the black powder scattered, leaving the glumes empty except for the remnant of the membrane. Some of the powder adheres to the outside of the glumes, giving them a black color, and it is by this appearance that affected grains are most readily detected in the field, they being otherwise rather inconspicuous. But frequently the glumes of sound grains are black, either from spores of black smut reaching them from nearby affected grains, or from the growth on them of the dark mycelium of another and saprophytic fungus. The presence of the black powder filling the seed is the distinctive indication of black smut.

THE CAUSE.

The condition described above is due to the development within the rice grains of a true smut fungus known as *Tilletia horrida* Tak. It belongs to the same genus as the stinking smut of wheat. Within the grain the fungus at first occupies a rather superficial position outside the aleurone layer, and grows especially well among the cells of the inner portion of the integument. An extensive cavity is gradually formed between the seed covering and the endosperm, and is filled with the black spores of the fungus—(Fig. 11); finally the whole substance of the grain except the outer coat is replaced by a densely packed mass of spores.

The spores are large, 22-28 mu., and generally spherical; sometimes they are slightly oval and have then a length of about 28 mu. The spores when mature are black and densely opaque; their surface is covered by a hyaline envelope, and is marked by deep and rather small alveolations—(Fig. 12, b). In very early stages the spores exist as thin-walled terminal swellings of short fruiting branches of the intercellular mycelium—(Fig. 12, a).

Germination of the spores of *Tilletia horrida* has not been observed by the writer, although repeated attempts have been made with perfectly fresh spores as well as with older ones. The spores were subjected to a number of conditions beforehand, and many different kinds of media were used. In the description of the fungus given in the Tokio Botanical Magazine (vol. X, p. 20), the sporidia are described as being filiform, ten to twenty in number, and 38-53 mu. in length.

OCCURRENCE.

In Louisiana the writer has found *Tilletia horrida* only on Honduras rice and red rice. Mill men have told him that it has been seen by them occasionally on Japan rice, and that on Honduras it is sometimes abundant enough to cause the rough rice to be graded down considerably; but this is very rarely the case. On the whole black smut causes very little loss, although it seems to be a little more prevalent than green smut. On account of the grains being only slightly if at all enlarged, they are not sifted out in the threshing; but at the mill they are broken in the first husking process, and as a rule do not occasion any trouble. In South Carolina, however, some years ago there was serious damage to rice flour on account of the dark color produced by the presence of spores of black smut. Samples of the rough rice from which the flour was made showed three or four per cent of the grains to be affected with the smut, and some of the affected heads had 25 per cent of the grains smutted.

In Japan the black smut is not so abundant as the green smut, and is not considered to be of economic importance.

MODE OF INFECTION.

In the course of his investigations upon black smut, A. P. Anderson (S. C. Agr. Exper. Sta. Bull. 41) found mycelium supposed to be that of the smut fungus in the stems of affected plants, and it was thought probable that infection takes place in the seedling stage from spores lodged upon the exterior of the rice grain. Seed treatment was recommended for the control of the smut. The smut did not spread beyond the originally infested district, and four years later had apparently disappeared.

In considering the value of this evidence as indicating seedling infection in the case of *Tilletia horrida,* it must be remembered that in flower infection by smuts, as well as in seedling infection, the mycelium grows upward in the young tissues of the plant. In so far as the accounts go, the efficacy of the seed treatment was not determined by controlled tests, and it is just possible that the diminution or disappearance of black smut in this instance was due to other and natural causes, and not to seed treatment.

An attempt to test the matter of seedling infection was made in 1907 by planting seed that had been thickly covered with *Tilletia* spores. About two hundred plants matured heads, but no black smut appeared. A number of seedlings in young stages sprouted in sterilized soil from seed thickly covered with spores, did not show mycelium when sectioned.

During the season of 1907 a large number of rice flowers were treated with *Tilletia* spores in the ways described above for the green smut. The seed from these will be planted this year to test the matter of flower infection.

In a certain lot of smutted heads, 33 had one affected grain; 35 two grains; 22 three grains; 9 four grains; 3 five grains, and one head in each case had six, seven and eight affected grains. It was further observed that in about three-fourths of the stools showing smut, more than one head of a stool was affected. A very striking instance of this limitation of the infection to single plants was seen in a field of Japan rice, in which about one stool in 100 was Honduras. The distribution of the latter was quite even in the field. Of the Honduras stools about one in three on an average showed smutted heads, and in most cases there were several such heads to the stool. Careful search did not reveal any smut on the Japan, although it was ready for harvesting. The owner stated that the land had been continuously in Japan rice for a number of years; that he had supposed he was planting only Japan at the last seeding; and that the seed rice had been bought from a party in another part of the parish. These evidences of stool infection would argue equally for seedling and for flower infection.

CONTROL.

As has been indicated, treatment of rice seed with such fungicidal substances as formalin, bluestone, potassium sulphide and hot water, had been practiced for the control of black smut, and is reported to have been successful. Whether such treatment is entirely reliable must be determined by further tests. At present it is the only means of control that it is possible to recommend. Full directions for carrying out the fungicidal treatment of seed of cereals will be found in Farmers' Bulletin 250, issued by the Department of Agriculture.

The use of seed grown in non-infected localities is always a sure means of avoiding cereal smuts when infection occurs at the time of flowering, and the mycelium is carried over within the tissues of the seed.

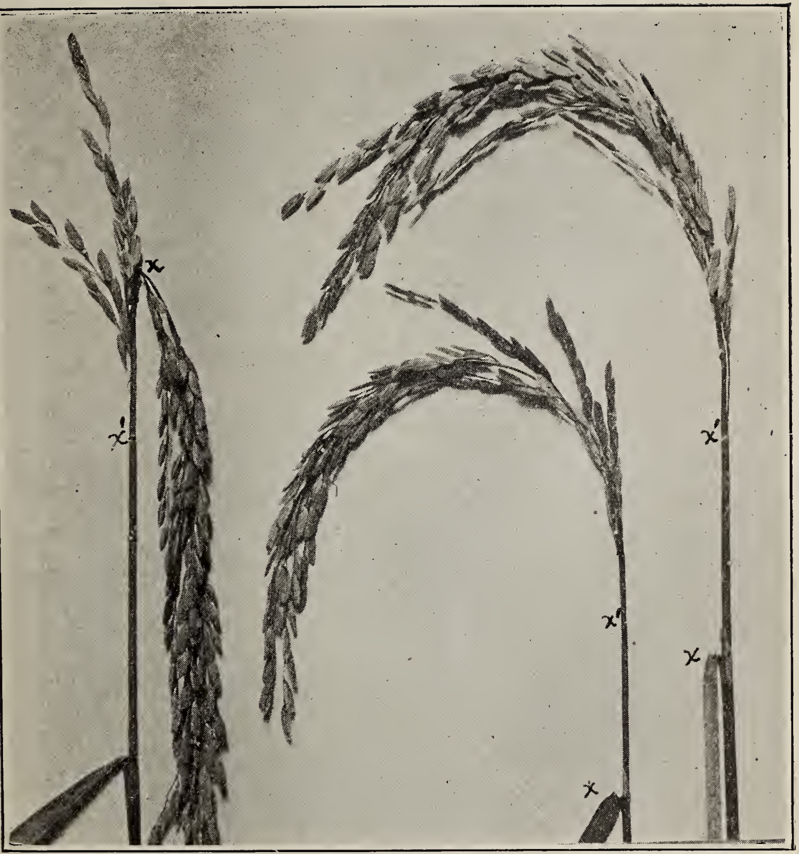

FIG. 1.—Heads of rice affected with blast. The discoloration of the neck region X-1, does not show well in the photograph.

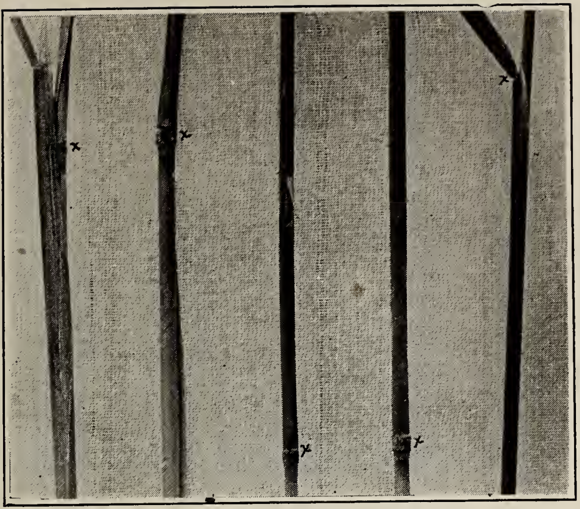

FIG. 2.—Stems of blasted rice showing characteristic lesions at the points marked X.

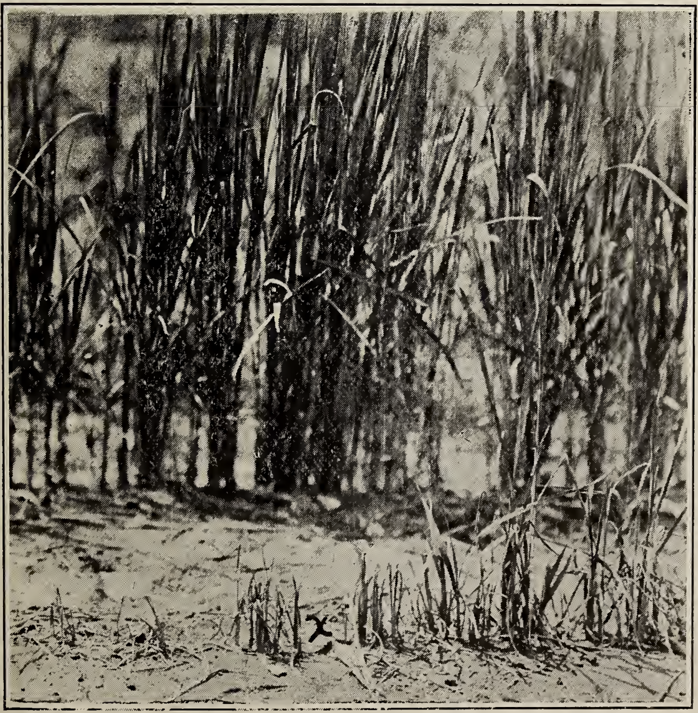

FIG. 3.—Young rice destroyed by blast. The row in the background is several weeks older than the affected row, and is not injured.

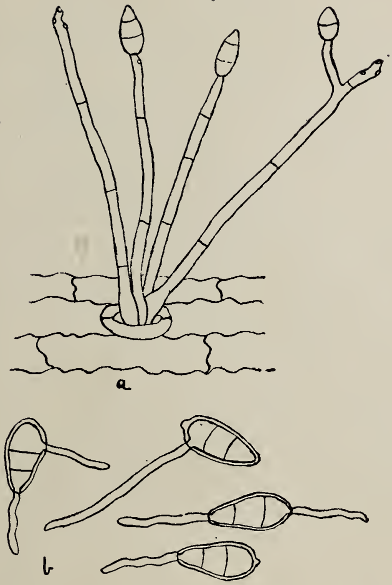

FIG. 4.—The rice blast fungus *Piricularia grisea*. a. A group of spore-bearing branches, X 265. b. Germinating spores, X 450.

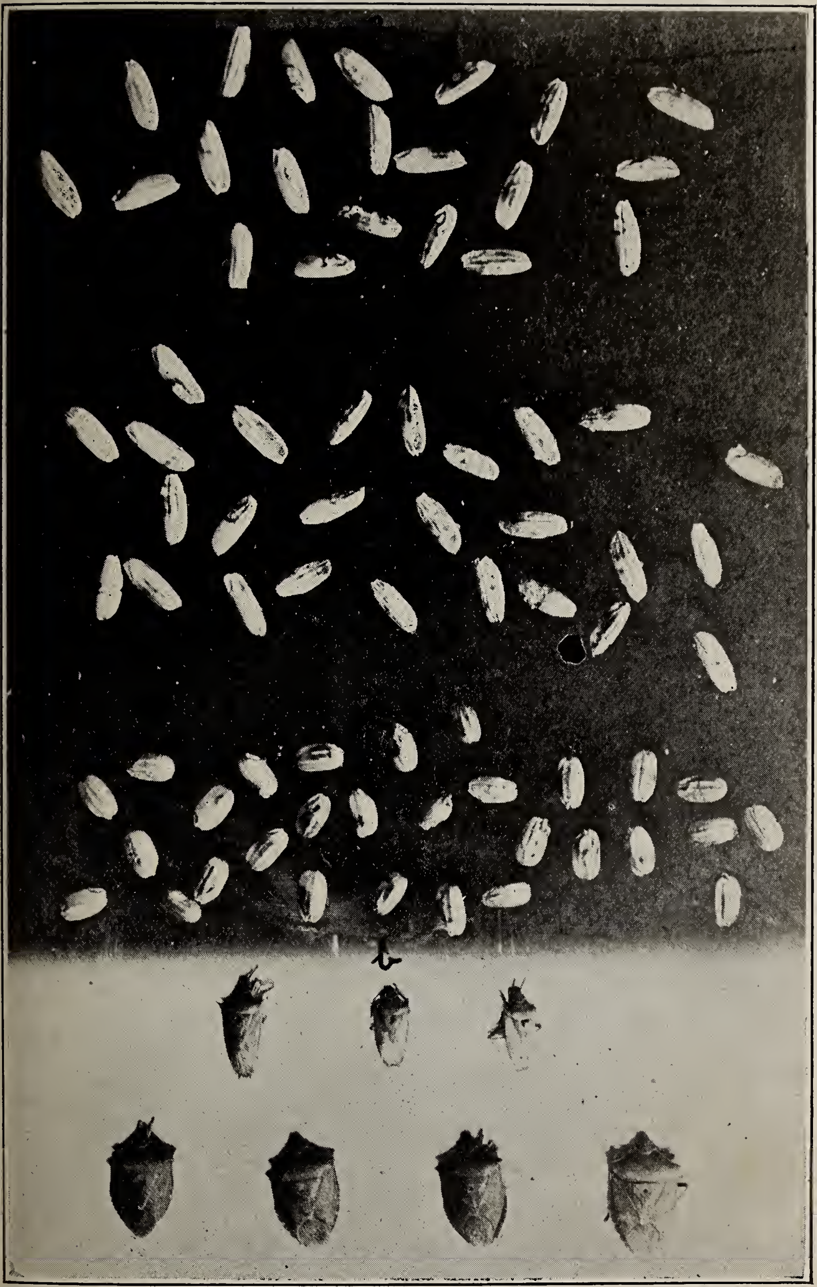

FIG. 5.—a. Grains of rice affected with brown spot. Those in the uppermost group are from heads covered with bags under which insects were placed. The other two groups are Honduras and Japan rice attacked under natural conditions. b. Insects that attack rice grains. Upper row, *Oebalus pugnax*; lower row, *Euschistus tristigmus*.

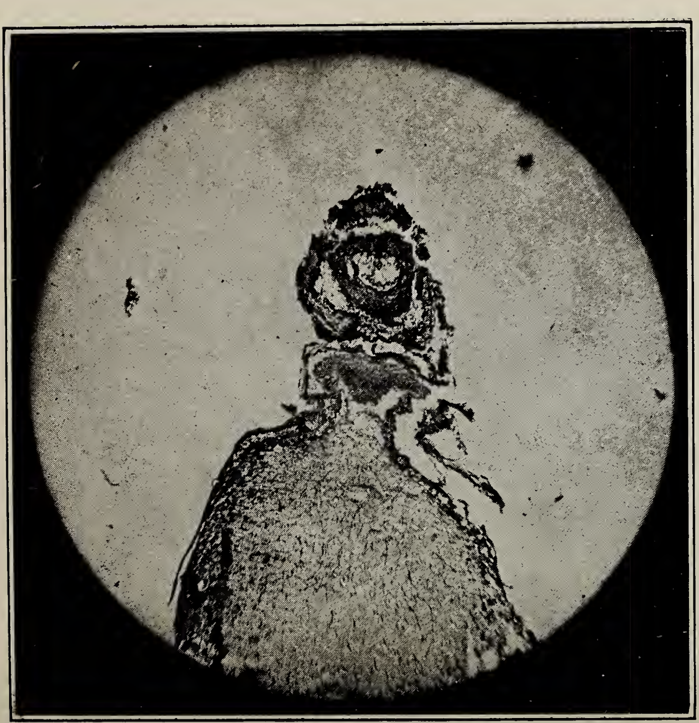

FIG. 6.—Grain of rice shriveled by the growth of a fungus within it.

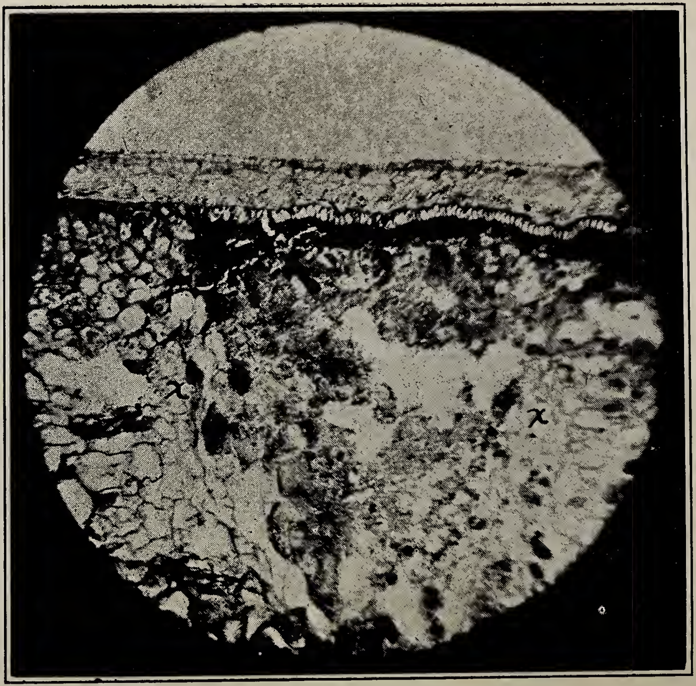

FIG. 7.—Section through a small spot on a rice grain. The space from X to X is disintegrated and filled with bacteria.

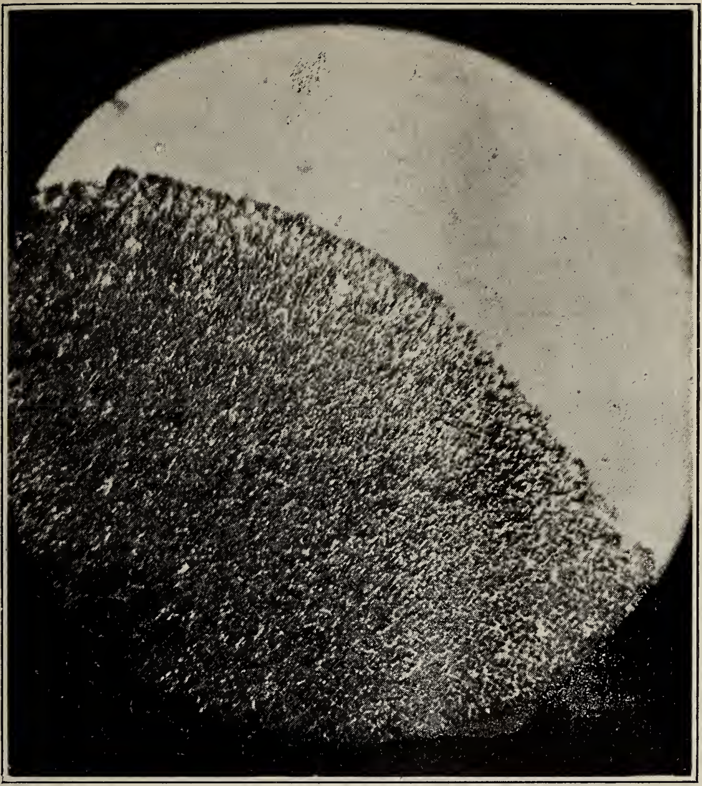

FIG. 8.—External or spore-forming portion of sclerotium of *Ustilaginoidea virens.* Highly magnified.

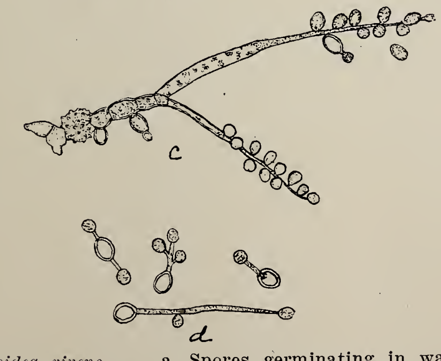

FIG. 9.—*Ustilaginoidea virens.* a. Spores germinating in water, X 1300. b. Spores germinating in bouillon. c. Spore germinating in acidified sugar solution; sporidia in clusters of many; one germinating while still attached. d. Germination of detached sporidia in acidified sugar solution, b. c and d, X 650.

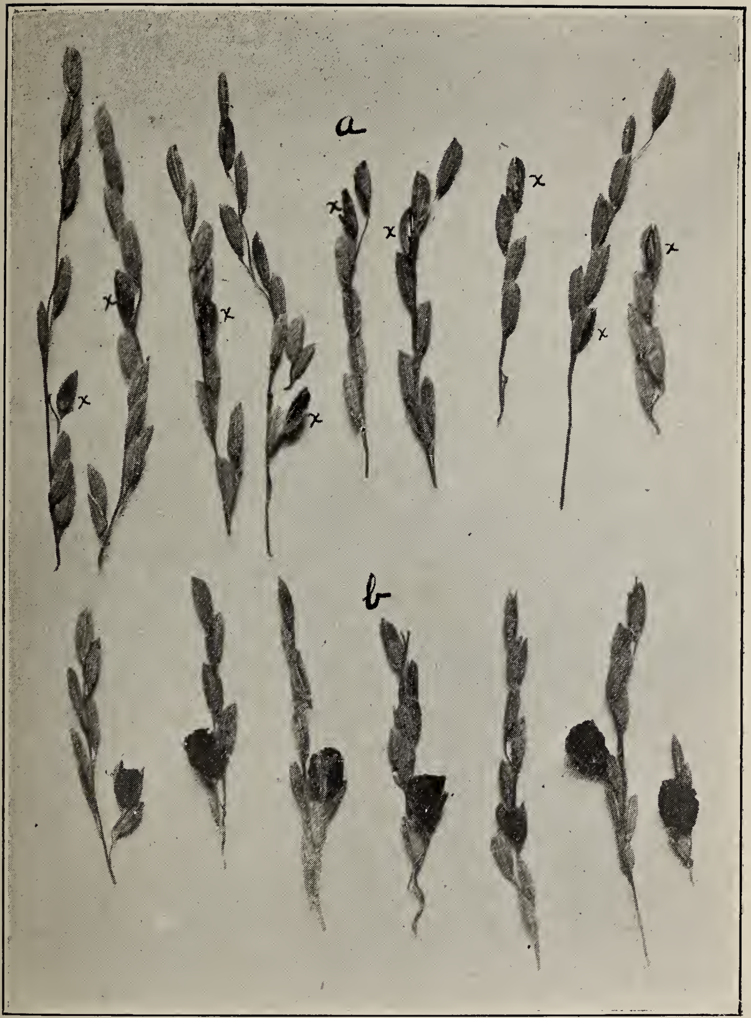

FIG. 10.—a. Grains of rice affected with black smut (*Tilletia horrida*).
b. Grains of rice affected with green smut (*Ustilaginoidea virens*).

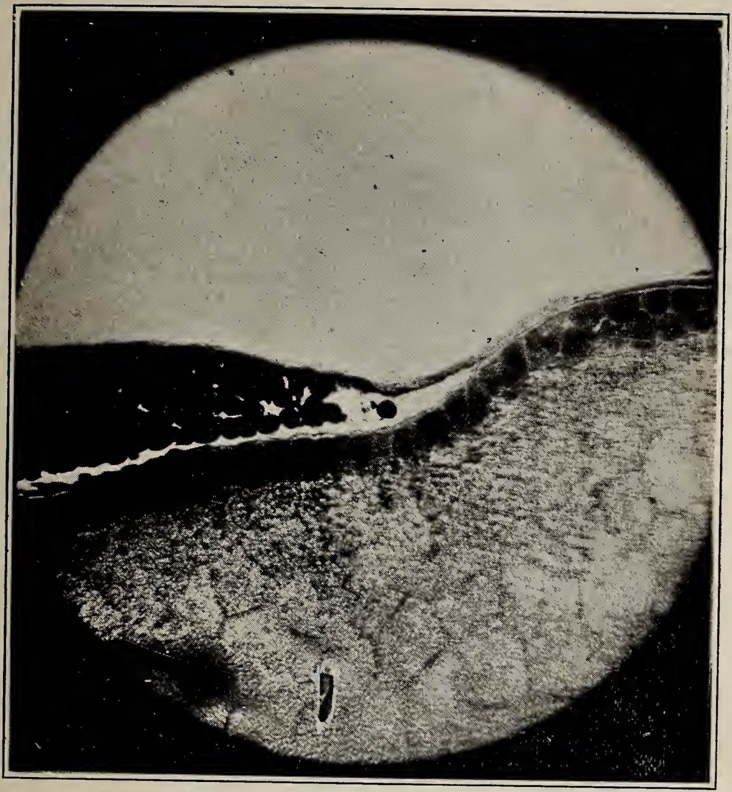

FIG. 11.—Section of rice grain affected with black smut, showing spores in the space between the cuticle and the aleurone layer.

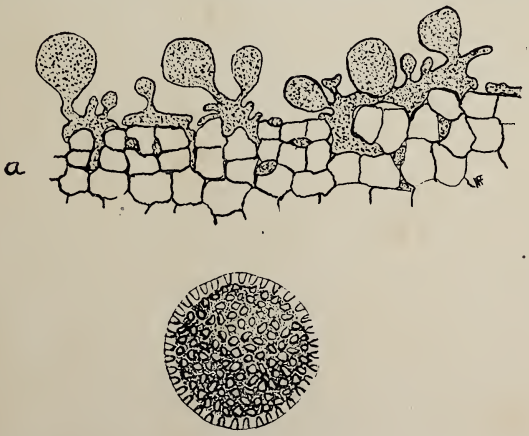

FIG. 12.—a. Mycelium and early stages in spore formation of *Tilletia horrida*. b. A mature spore. a and b, X 1000.

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AGRICULTURAL EXPERIMENT STATION

OF THE

Louisiana State University
and A. and M. College,

BATON ROUGE.

A Preliminary Report

ON THE SO-CALLED

Cerebro-Spinal Meningitis of Horses.

BY

H. J. MILKS, D. V. M.

The Daily State, Official Journal of Louisiana.
BATON ROUGE:
1908.

A PRELIMINARY REPORT

ON THE SO-CALLED

Cerebro-Spinal Meningitis of Horses.

BY H. J. MILKS.

During the fall of 1906 and the summer of 1907 Cerebro-Spinal Meningitis was very prevalent in certain parts of this State. It is known as: Staggers, Blind Staggers, Sleepy Staggers, Bottom Sickness, etc.

Occurrence—The disease was not confined to any particular locality. It occurred in lowlands, and in the hill and bluff districts. It attacked animals of all ages and, we believe, horses more than mules. The outbreak extended over a large area, but did not usually attack many animals at the same place, although one owner lost all his horses (three) in the course of three or four days. Animals were attacked at rather widely separated places. We have seen it on both sides of a bayou, extending several miles. It was not confined to animals fed upon any one feed, though the majority of those attacked were allowed to graze.

Cause—Numerous theories have been advanced as to the cause of this disease. It has been attributed to grazing upon low, marshy places, hence the name Bottom Sickness. The cause also has been laid to mouldy corn or fodder, poisonous plants, exposure to sun, impure water, etc. Mayo, reporting a very similar disease, concludes it to be due to a fungus, *Aspergillus glaucus*. The spores enter the circulation, find lodgment in the organs and set up inflammatory conditions. The cerebral symptoms were due to an abscess of the brain. He has also recovered the above fungus from the different organs.

Chester, of the Delaware Station, has carried on a series of feeding experiments with negative results. Some even point out the infectious nature of the disease.

In Louisiana the disease attacked animals upon such a varied diet that it is hard to connect it with any particular food. As will be seen later from the case reports, the disease attacked animals fed upon hay and oats, hay and corn, oats and grass, hay and grass, and grass alone. To be sure, many of the animals alleged to have had no grass have still had it in certain amounts. One case, that of a foal four or five days old, reported by Dr. Joseph L. Drexler, of Thibadoux, seemed to contract the disease through the milk of its mother. The mother died of the disease a day or so before the foal. The foal showed all symptoms of the disease.

It can hardly be attributed to toxic plants, or a greater number of animals, kept under exactly similar conditions, would have taken the disease instead of such widely separated cases. This also applies to the theory of infection, because it would seem that many more animals would have been affected. However, if due to a micro-organism, that organism must have great difficulty in entering the body, but when once it gains entrance it must be especially active. Furthermore, if due to a micro-organism our methods are at fault or the organism is too small to be observed.

Symptoms—In the mild cases we got dullness, stupor, weakness, hanging of the head, paresis or slight loss of control over one or more limbs, a slight rise in temperature, 102° to 103° F., often difficulty in swallowing. The visible mucosæ were congested and brownish yellow. In these mild cases the weakness never became so great that the animal could not stand and usually it was able to take some nourishment and water.

The more severe cases were manifested by the same general symptoms, often, however, the respirations were much increased and labored. The temperature ran to 104°-106° F. Pulse might be practically normal or accelerated and hard. Opisthotonus was not marked nor often present. They became rapidly weaker, often partially blind, stood with all legs in a bracing attitude and sometimes found support against the side of the stall or fence. Sometimes they were delirious and would stand with the head pressed against the wall, or turn in a circle either to left or right. There was sometimes heat in the region of the poll and coldness of the extremeties. Usually the severe cases were unable to stand after 12 to 36 hours, and fell unable to rise again. They then died in a delirium within a few hours or lay in a comatose condition from 12 to 36 hours. In the delirious cases the temperature usually kept up pretty well, respirations and pulse were also much accelerated, while in the comatose condition the pulse returned to about normal, temperature to nearly normal, and respirations as though the animal was in a deep sleep.

As the disease progressed we occasionally got a fetid discharge from the nose and mouth, due no doubt to decomposition of the secretions retained in those parts.

In the severe cases the animals usually refused food, but often showed a desire for water, although unable to drink. The digestive tract was almost completely paralyzed. Purgatives seemed to do little good, no matter what the dose. The hypodermic use of eserine or arecolene did not produce purgation, but did exhibit other physiological phenomena.

Course and Mortality—The disease generally runs a rapidly fatal course, lasting from a few hours to four or five days—usually not more than three or four days. The time given by some authorities, 8 to 12 days, is entirely too long, except in cases that survive.

In those cases that survived, the disease attacked slowly, the animal usually *taking* some nourishment and showed all the symptoms of a mild attack.

The mortality was 90 per cent or more. Treatment availed little, unless started in the first few hours of the disease, and even then prognosis was unfavorable.

POST-MORTEM APPEARANCES.

Buckley (Maryland Bulletin 53, 1898) noted slight congestion of the stomach in some cases, intestines unchanged, except for dry fecal matter in the posterior part. Spleen and liver unchanged. Kidneys natural in size and color. Heart and lungs usually unchanged, except in case of the latter, when the animal had been down a long time, there might be a slight congestion on the under side. The meninges of the spinal cord and brain showed greater or less degree of congestion. The *septum nasi* was covered with a fetid discharge; its blood vessels were injected.

MacCullum (in Journal Exp. Med., Vol VI, No. 1, November, 1902) made examinations of several brains from the outbreak referred to above and found as follows: Four brains examined; none showed any signs of the presence of an inflammation of the meninges. In the frontal region on each side, anterior to the motor region of the cortex, there was a slightly depressed area, softly fluctuant, but not marked by any superficial hyperæmia or discoloration. On sectioning this brain a glairy fluid with small granular pulpy masses of whitish tissue flowed out from the softened area. The lesion seemed almost entirely limited to the underlying white matter.

Microscopically there was complete destruction of the brain substance, which was partially replaced by a colloid-like material. The blood vessels in an infected area showed a marked inflammatory condition, with exudation of red and white cells into the perilymph space. Hyalin-like material was also found in the blood vessels. These formations were mainly found in the small vessels. In a later outbreak of the disease he was unable to find the lesion of the brain, but did find that of the blood vessels.

Moore, V. A., has been unable to find any changes in the nervous system and other organs that could be detected by gross examination. In one case the above organs were examined microscopically with similar results.

McCarthy and Ravenel found lesions in the upper gastrointestinal tract and in the nervous system. The latter were divided thus:

1. Small round celled peri-capsular infiltration of the intervertebral and gasserian ganglia.
2. Congestion of the cerebral and cerebellar cortex and capillary hemorrhage.
3. The choroid plexus was changed into a triangular tumorlike mass, due to a proliferation of the elastic tissue surrounding the vessels.
4. Distinct degenerative changes in the nerves supplying the larynx and neck.

Mayo (Kansas Bulletin 24, September, 1891) says that the circulatory and respiratory systems were normal, except a slight greenish tinge to the mucosæ in some cases. There was more or less irritation to the stomach and small intestines, but not enough to cause serious symptoms. The large intestine usually contained a large amount of feces. In all cases the liver was congested and sometimes the kidneys also.

In our investigations the post-mortem lesions were based upon five cases. In all cases the blood vessels of the meninges and the brain showed congestion. (Fig. 1.) Otherwise the brain substance and cord appeared normal. Cross sections of the brain and medulla showed much ecchymosis and extravasation of blood. In some cases there was much fluid beneath the dura; in others only a slight amount. No softening or other microscopic lesion could be detected.

The blood was usually dark and did not clot readily. Heart was usually normal, but frequently contained anti-mortem clots. The lungs were normal, except for a slight hypostatic congestion on the under side. The digestive tract was apparently normal, except that the posterior end usually contained much dry fecal matter. In one case there was marked congestion of the last fourteen or sixteen feet of the small intestine. In another case there was slight congestion. However, this condition did not show from the exterior and may have been overlooked in other cases.

The liver usually contained much blood, spleen normal in size and appearance and might contain much blood or be very dry. The kidneys showed slight congestion, but were otherwise normal in appearance. The bladder usually contained apparently normal urine.

Microscopic examinations were made of the brains and kidneys of two horses and the liver, spleen and intestine of one. Briefly stated, there were shrinkage of certain of the cells of the nervous tissue of the brain and inflammatory conditions, especially around the blood vessels. The blood vessels also contained much blood. The kidneys and liver showed some granular degeneration and congestion. In one case the blood vessels of the kidneys showed a similar condition to those of the brain. The spleen appeared normal, except for the large number of white blood cells. These appearances will be described in detail in a later part of this bulletin.

The following places were visited and a few cases will be described from each outbreak:

HOWARD, LA.

(August 27, 1906.)

Case 1—Mare, in good condition. This case had the following history: She was first noticed weak and stumbling blindly about. The owner said that she was breathing badly and had high fever, though he did not use a thermometer. When seen by the writer she was lying broadside in a comatose condition; respirations regular and deep, as in sleep; pulse slightly weak and accelerated; temperature 102.5° F.

Case 2—Mare about to foal, was in the first stage of the disease; was slightly blind and was so weak that she would stagger if moved. Temperature 104.5° F. Respiration and pulse much accelerated. She was still able to eat and drink. This was 8 o'clock in the evening. The following morning she had foaled a living colt, was unable to rise, but continually struggled to do so. She was unable to stand when assisted to her feet; quite blind and delirious. Temperature 100° F. Respirations and pulse slightly increased. Visible mucosæ anæmic.

Case 3—This was a post-mortem upon an animal belonging to the same owner, as Case 2. She died the night previous.

Brain—Blood vessels of the brain and meninges injected. Much effusion in the sub-dural space. Cross sections of the brain and medulla showed numerous areas of petechiæ and blood extravasations. No softening or change in consistency of the brain substance could be made out. The trachea contained much exudate of a very offensive nature. Lungs were hepatized, especially the lower one. The blood was dark and frothy and did not clot readily. The heart was normal in appearance but contained anti-mortem clots in both halves extending from the auricles through the ventricles into the aorta and pulmonary arteries for three or four inches. The spleen and liver contained much blood. The kidneys showed slight congestion.

Case 4—This was the last of the above owner's animals. He had already lost two, one was very sick and as we were about to leave he led up his last one, already partially blind, very weak and showing every symptom of the disease. Pulse 60, respirations 25, and temperature 105.5° F.

LOCKPORT, LA.

The disease had been raging in this vicinity on both sides of the bayou (Lafourche) for several weeks. The following cases will be mentioned:

Case 1—A large gray mare, in good condition, was attacked Tuesday morning; in the evening was given a purge, with no appreciable effect. On Wednesday she fell and was unable to rise afterwards. Thursday night we saw her, a few minutes before she died. At this time the pulse was very rapid; respirations labored and temperature sub-normal. This animal was used in a livery establishment and was first noticed ill as above stated. The first symptoms were drowsiness, weakness and persistent turning in a circle, always toward the same side. She rapidly grew weaker and finally fell. Her feed had been timothy hay and oats. No grass could be accounted for, unless allowed to eat while on a trip.

Case 2—A doctor's driving mare became affected about the same time as the above animal, but did not have so severe an attack. Instead of being comatose she was delirious. At the time we saw her she was convalescing, but very weak. Respirations and pulse normal. Temperature 97° F. Her treatment had consisted mainly of stimulants. Later it was reported that she had recovered. Feed was hay and oats.

Case 3—Gray mare, in fair condition, was taken sick at 10 o'clock Thursday night. The following morning her temperature was 104.8° F. Pulse and respirations slightly accelerated. Very weak and stupid. Ice had been applied to the poll and back during the morning. She grew rapidly worse and was unable to stand after a few hours. An aloes purge was administered, with no apparent effect. Died Saturday morning. Feed had been corn and grass. The corn was native grown, and was from the same crib from which she had been fed all the previous winter and spring.

Case 4—Bay horse, convalescing. This animal had suffered a mild attack, was never unable to stand and at this time was able to take some food and water. Feed hay, corn and grass.

Case 5—A large mare, in fine condition. This case was across the bayou from the preceding animal. She was taken sick the previous night; was very uneasy and persisted in turning in one direction. She became rapidly worse and fell about daybreak, unable to rise again. At 10 o'clock in the morning she was lying broadside, in a semi-comatose condition; pulse and respiration normal. Temperature 103° F. Feed consisted of hay and corn, such as she had been fed all the year; no grass, except what she picked to and from work. This owner had lost one or two horses with a similar disease a few months previous.

Case 6—Horse, taken sick Saturday morning. In the afternoon his pulse and respirations were practically normal. Temperature 104° F.; was very weak and would fall whenever moved. Feed was corn and forage.

Case 7—Horse, became affected at 10 o'clock in the morning. Led home a distance of ten miles. At 5 o'clock in the afternoon temperature 104.8° F. Pulse 45. Respirations slightly labored and accelerated. He was very weak and drowsy. A purge was administered, also two drachm doses each of potassium bromide, quinine and belladonna every three hours. It was reported that he survived. Feed: hay, corn and a small amount of forage.

Case 8—A two-year-old filly, taken Friday evening. She was first noticed very weak and drowsy. At 10:30 o'clock the following morning her temperature was 101.4° F. Breathing and pulse normal. She was very weak and presented a very typical case of the disease. Feed was entirely of grass.

THIBODAUX, LA.

Several animals were studied in this vicinity. The following case will be given in detail. Several post-mortems were made. The results of two typical ones will be included.

Case 1—This was a young high-strung saddle horse. He was used one-half day, Monday, and nothing wrong could be detected with him. The following day at noon he was noticed sleepy and drowsy, though he had been playing in the stall during the forenoon. He was then given one pint of raw linseed oil, nothing else being done except to keep him cool, clean and quiet until Thursday, when a local veterinarian was called. At this time the temperature was 105° F. Ice was used upon his spine and head. July 6, 3 p. m., he fell, after being sick sixty-three hours, but after resting an hour or so he recovered so far as to be able to rise, but soon fell again. At this time the temperature was 104° F.; pulse 58; respirations 36. His temperature was never less than 104, often as high as 106, and just before he died (Saturday night at 8 o'clock) his temperature reached 108° F. Respirations 72. It was impossible to count the pulse. The owner said that he had never seen a horse suffer so much during the last hour. He was sick four days and fourteen hours. During this time he never lost consciousness. Liniments were tried over the brain, but they produced so much excitement that they had to be removed. His feed had been oats, bran, alfalfa and green corn. No grass in the previous four weeks.

Post-Mortem No. 1—Mare, in good condition; sick about three days.

Heart—Normal, in diastole. Blood dark and tarry; did not clot readily. Lungs slightly discolored, especially the lower one.

Brain—The blood vessels of the brain and meninges showed much congestion. Cross sections of the brain substances showed many petechiæ and blood extravasations. No softening or other conditions were detected.

Liver—The liver contained much blood, which was thin and showed an abundant black precipitate.

Spleen—Weight 1½ pounds. Was white and bloodless. It was with difficulty that blood could be obtained for films.

Kidneys—The kidneys were slightly congested. Weight 1½ and 2 pounds.

Digestive Tract—Normal. Contents were in a soft condition, except in the posterior part, where it was dry and hard. Stomach contained only a little colorless fluid.

Post-Mortem No. 2—Bay gelding. Sick two and a half days. Blood slightly darker than normal and did not clot readily. Heart normal. Pericardium slightly congested. Lungs normal, except a slight congestion on the inferior side.

Brain—There was much congestion of the blood vessels of the brain and meninges, but no change in consistency. The substance of the brain was ecchymotic.

Liver—Weight 24 pounds. Dark in color and slightly congested.

Spleen—Very much darkened. Contained much blood and weighed six pounds.

Kidneys—Some slight congestion. Weight 2 pounds and 2½ pounds.

Digestive Tract—Stomach and other organs apparently normal, except the posterior part, which contained hard, dry feces.

BATON ROUGE, LA.

Case 1—Post-mortem of a four-year-old mare. This animal was first noticed sick in the evening. Died the following day at 1.30 p. m. The post-mortem was made one-half hour after death.

Brain—The blood vessels of the meninges and brain substance were much injected. The brain substance showed congestion and cross sections showed numerous petechiæ and ecchymosis. The medulla had the same appearance. No change in consistency could be detected. The cord in the lumbar region was normal. Trachea and lungs normal. Blood dark. Heart normal in size and appearance. Both ventricles contained anti-mortem clots.

Stomach—Normal in appearance. Contained much sour feed and grass.

Small Intestines—The intestines appeared normal from the exterior, but when opened showed pronounced inflammatory conditions of the posterior fourteen to sixteen feet. The mucosa was much inflamed and easily detached. The intestinal contents was a watery blood-colored liquid. The large intestine was normal, except for a large amount of dry feces.

Kidneys—Normal in size and slightly congested. Bladder empty.

Spleen—Normal in size and contained much blood.

PATHOLOGICAL HISTOLOGY.

Horse No. 1—All organs removed within one hour after death. Brain fixed in formalin; all other tissues in sublimate.

Brain. Except for a shrinkage of certain of the nerve cells there was but little change in the nervous tissue. The blood vessels of the pia and arachnoid and of the brain proper were filled with blood. In the larger vessels especially, numerous leucocytes, mostly of the polynuclear variety, were seen within the vessels, passing through their walls and in the tissues surrounding the vessels. (Fig. 2)

The smaller vessels showed the same general conditions, except the vessels were shrunken, and red and white cells had in many cases passed into the perilymph space. Few leucocytes had, however, invaded the tissues from the small vessels. In some areas many polynuclear leucocytes were present in considerable numbers throughout the section. Few red cells have been found without the perilymph space.

Sections of the hippocampus showed the blood vessels to be in the same condition as in the other areas of the brain.

Kidney. Considerable hyperæmia was present, also a slight degeneration and desquamation of the epithelial cells of the tubules.

Liver. The inter and intra-lobular veins contained much blood, in which were many leucocytes, mostly of the polynuclear variety. These leucocytes were also found in the tissues surrounding some of the larger blood vessels and even passing through their walls. (Fig. 3.)

Intestine. Portion found congested at a post-mortem examination. The coats of the intestine were thickened, especially sub-mucosa. There was a slight hemorrhage in the mucosa and congestion of the vessels of the mucosa and sub-mucosa. Considerable fibrin was seen in the sub-mucosa. Leucocytes were present in fairly large numbers in the mucosa. Many of these were of the plynuclear variety. (Fig 4.)

Spleen. Nothing abnormal except a considerable number of polynuclear leucocytes in the pulp.

Brain No. 2—Sublimate fixation. Animal sick four or five days. Brain removed 18 hours after death. The blood vessels showed the same conditions as those described in Brain No. 1. Post-mortem changes, however, were so great that other conditions could not be studied.

Kidney No. 2—Horse sick three days. Kidney removed six hours after death. Hyperæmia not so marked as in Case 1, although the larger blood vessels were congested. (Fig. 5.) The glomeruli were congested. A moderate amount of fibrinous exudate was found between the tubules and granular degeneration and desquemation of the cells of the tubules was quite marked. The capillaries were also congested. Figure 6 shows the degeneration of the tubules.

BACTERIOLOGICAL INVESTIGATION.

Cultures were made from the brain, liver, spleen and heart from a number of animals, but no growth took place except in one case, in which there was evident contamination, as only the pus organisms were recovered. Smear preparations were also made from the various organs, but no bacteria could be found, except in one case a gram-negative diplococcus was found in the exudate from the brain. The smears were stained for both bacteria and protozoa.

BLOOD EXAMINATION.

Complete examinations were made in only three cases. The blood was collected from an ear vein or a piece of the ear clipped off with scissors. In either case care was used to have the place free from hair, dry and clean. Gower's hemoglobinometer was used for the hemoglobin content. The blood was used in a dilution of one to one hundred in Toisson's fluid. Both red and white cells were counted in the same preparation in a Zappert-Ewing counting chamber. One hundred squares were counted for the red, the whole rules space for the white. Two counts were made and an average taken, unless great variation occurred, when other counts were made.

BLOOD COUNT.

No.	Hb.	Reds.	Whites.	Leucocytes.	Poly's.	Eosin's.	Mono-nuclears.	Mast.
1	60	5.304,000	8.500	33.8	52.1	1.3	12.1	.7
2	90	5,676,000	10,600	13.1	73.9	....	12.5	.5
3	62	6,840.000	12,330	30.1	59.9	2.	6.6	1.3

REMARKS.

No. 1 had been sick several days with a mild type of the disease. It later recovered.

No. 2 had been sick but 36 hours and died a few hours later.

No. 3 had been sick 10 hours and died twelve hours later.

INOCULATION EXPERIMENTS.

In all nine animals were inoculated—four rabbits, four guinea pigs and one horse. The animals were all adults and the inoculations made sub-cutaneously. The blood used was drawn aseptically from the jugular vein into sterile test-tubes and defibrinated under as aseptic conditions as possible. The citrated blood was about three parts blood and one part citrate solution (sodium chloride 0.85 per cent and sodium citrate 1 per cent). The brain emulsion was made by grinding a portion of the brain substance in sterile distilled water. The source of material was, for inoculations 1 and 2, from a mule a few hours before death; for 3 and 4, from a horse with a mild attack of the disease and which later recovered; 5 was from a horse sick for three or four days and died two days later; 6 and 7, from the brain of the same animal as above, 10 hours after death; 8 and 9, from the brain of a mare, removed one-half hour after death and injected two hours later. Inoculations 6 and 7 were made at the place of the post-mortem.

TABLE OF INOCULATIONS.

No.	Date.	Animal.	Material.	Source of Mat.	Dose.	Remarks.
1	Sept. 10	Rabbit	Defibrinated Blood	Mule	1 cc.	Survived
2	Sept. 10	G. Pig	Defibrinated Blood	Mule	1 cc.	Survived
3	Sept. 20	Rabbit	Citrated Blood	Horse	1 cc.	Survived
4	Sept. 20	G. Pig	Citrated Blood	Horse	1 cc.	Survived
5	Sept. 24	Horse	Cit. Blood and Defib. Blood	Horse	1 cc. each	Survived
6	Sept. 26	Rabbit	Brain Emulsion	Horse	2 cc.	Died Oct. 10
7	Sept. 26	G. Pig	Brain Emulsion	Horse	2 cc.	Survived
8	Sept. 26	Rabbit	Brain Emulsion	Horse	2 cc.	Survived
9	Sept. 26	Pig	Brain Emulsion	Horse	2 cc.	Survived

No. 6 died October 10, very suddenly. Post-mortem showed marked emaciation. Brain and other viscera perfectly normal. Several animals in the pen from which this one was taken died in about the same manner and gave the same post-mortem appearances. Therefore we believe that the inoculation had nothing to do with this death. None of the animals showed any effect of the inoculation either by sickness or abscess formation at the point of inoculation.

CONCLUSIONS.

1. The cause of the disease or its infective nature has not been determined by these investigations. No micro-organism has been encountered that would account for the disease.

If we accept the statements of the different owners, regarding the character of the materials consumed by the different animals as absolutely accurate then the theory of food contamination does not seem to be well taken for the following reasons:

(a) The low per cent of animals affected under exactly similar conditions.

(b) The widely separated cases.

(c) The fact that the animals attacked were not confined to any particular feed or combination of feeds.

2. The pathological findings pointed out changes in the blood vessels of the brain and meninges. Degeneration and some other changes were present in some of the internal organs. Just how much of these pathological changes are due to the disease, and how much to the post mortem changes, is hard to say. In this climate post mortem changes take place so rapidly that it is difficult to get suitable material for study. However, in case (1) one the material was all removed and fixed within one hour after the death of the animal.

NOTE.

During the outbreaks recorded by this bulletin, our time was occupied chiefly in the field, endeavoring to discover and suggest immediate remedial and preventive measures; in consequence, more thorough and systematic investigations were interferred with, which, however, we intend to continue when the opportunity presents itself.

AS TO PREVENTION.

Although the exact cause of meningitis in horses and mules has never, as yet, been satisfactorily demonstrated, either in this country or abroad, it has been the opinion of Dr. W. H. Dalrymple, of this Station, who has experienced several previous outbreaks in Louisiana, during both the spring and summer months, that the cause was, in some way, associated with the condition of the feeding materials—either grasses or cured products, such as corn, etc.—brought about by the attack of molds or fungi; and that when a complete change, to food that was absolutely sound, was made, the disease was either checked, or disappeared entirely.

This, also, would seem to have been the experience of other investigators.

Consequently, until the exact nature of the agent producing meningitis, as well as a possible remedy, has been discovered, we would urgently recommend to stock owners, that, as soon as they observe the first symptoms of so-called "staggers," they at once make a change from feeding materials that are at all suspicious, to those that are perfectly sound. Or, as a matter of prevention at all times, that they do not supply to their animals, or permit them to consume, food of any kind that is not absolutely sound and free from molds or fungi.

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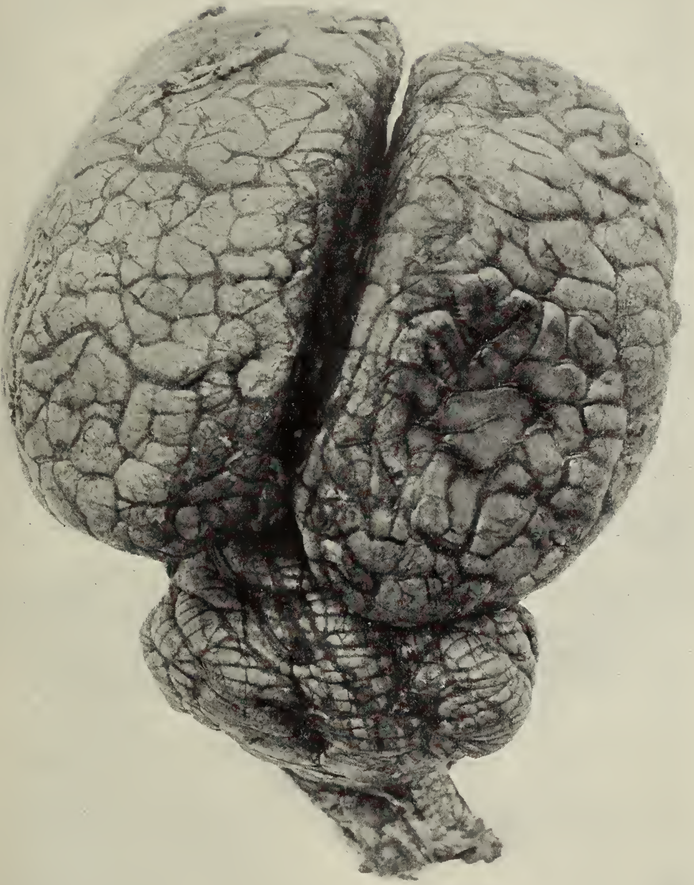

FIG. 1.—Brain of horse. Note the injection of the blood vessels.

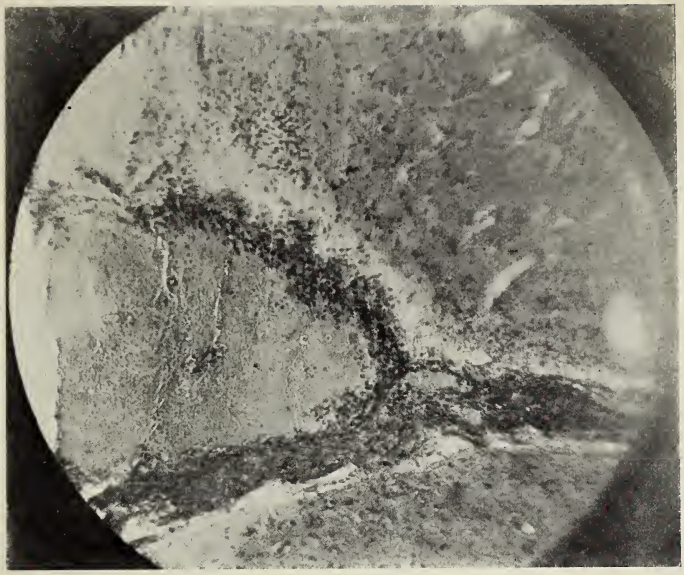

FIG. 2.— Photograph of section of a large vessel of the brain. Note the blood within the vessel and the numerous leucocytes passing through its walls and in the tissue adjacent.

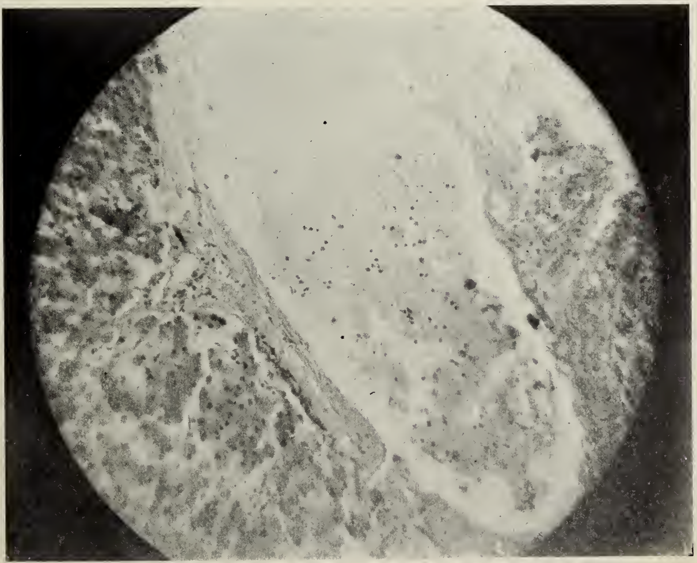

FIG. 3.— Photograph of section of liver of a horse through a large blood vessel. Note the large number of leucocytes within the vessel.

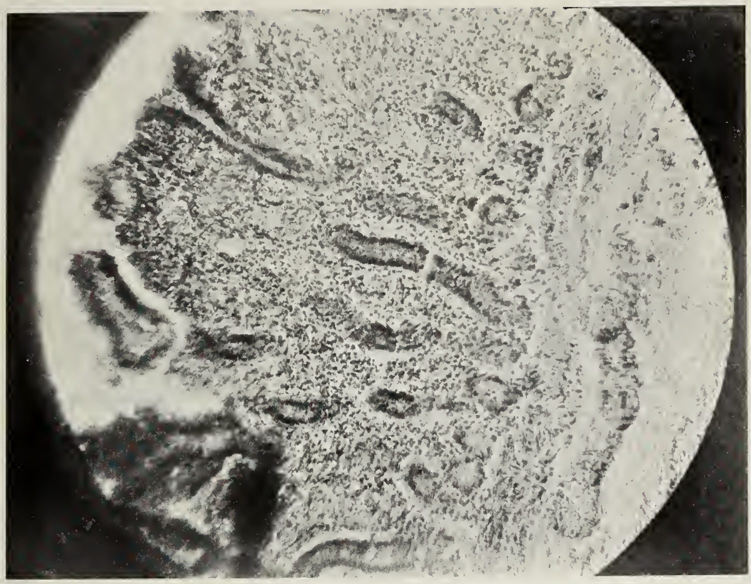

FIG. 4.—Photograph of section of intestine of horse showing large number of leucocytes in mucora.

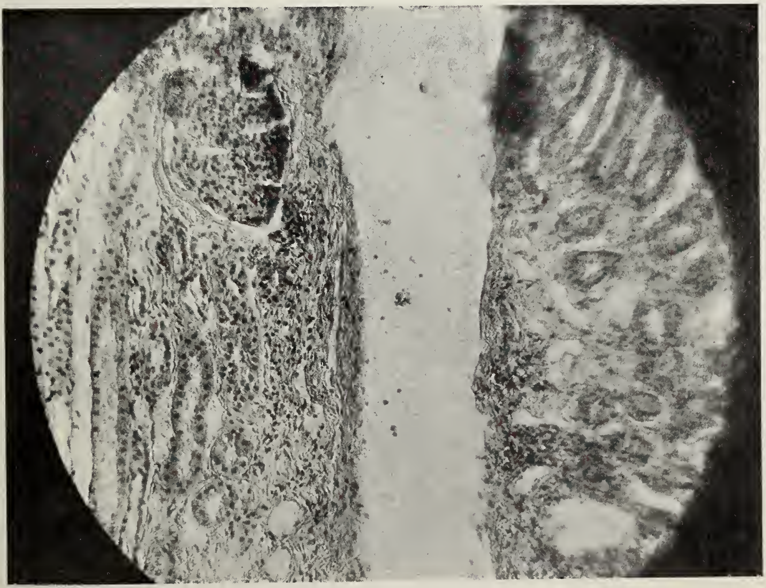

FIG. 5.—Kidney of horse showing congestion of the large blood vessels.

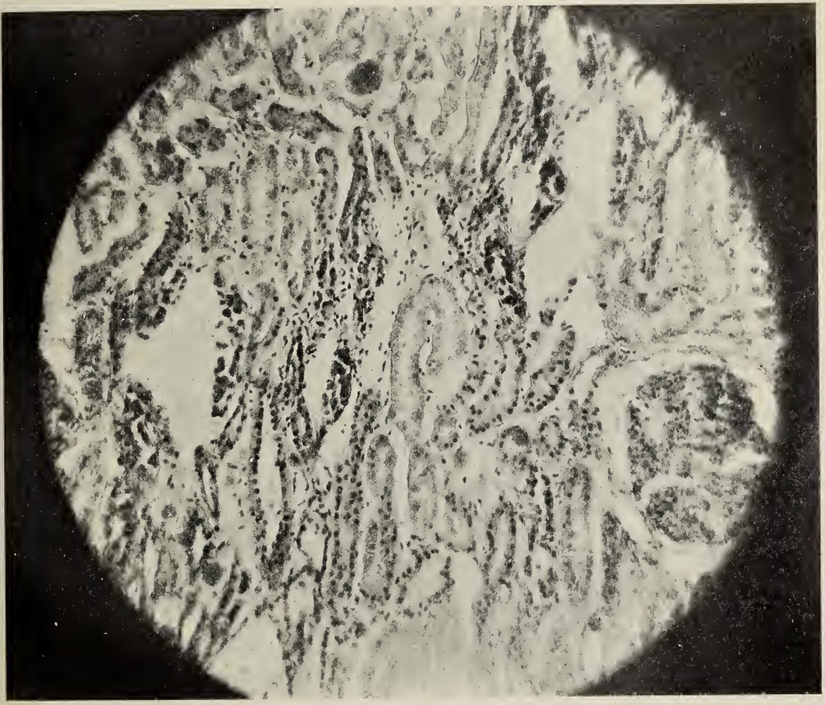

FIG. 6.—Kidney of horse showing degeneration of the tubules. The tubules to the right and in the centre show the condition especially good.

LOUISIANA BULLETIN NO. 107.

Agricultural Experiment Station

OF THE

LOUISIANA STATE UNIVERSITY and A. AND M. COLLEGE.

BATON ROUGE, LA.

Preliminary Tests of Sugar House Machinery.

BY

E. W. KERR, M. E.

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INTRODUCTION.

For the intelligent design and arrangement of the machinery of a power plant of any kind the designer should have at his command data regarding the capacity and the performance that may be expected of machines of different kinds and sizes. This data should be known, not only for the best operative condition, but for all conditions that are likely to occur in the operation of the machine. It is especially important to know something of the capacity under the least favorable conditions of practice as this largely determines the size of the machine which should be installed. For the machinery of ordinary steam power plants such as is used generally throughout the country, there is an abundance of data as regards both design and performance. Not only does such data exist, but it may be found in print, so that he, who will, may inform himself. For instance, the mean effective pressure, the steam consumption in pounds per horse-power per hour and the mechanical efficiency of steam engines of each particular type are accurately known and on record. In general, the same may be said of boilers, pumping machinery, hydraulic motors, electricity and perhaps to a smaller extent, gas and other internal combustion engines.

With reference to the machinery peculiar to sugar houses there seems to be little of such data. This fact has been forcibly brought to the attention of the writer who is responsible for a college course in sugar house engineering, a part of which course consists in designing and planning a complete sugar house outfit of a required capacity.

Being aware of the scarcity of printed information of the kind desired, it was decided that a series of tests, as complete as possible, should be made of sugar house machinery in order to get information as to the relations of capacity, energy consumed, and efficiency. Following is given the results of preliminary investigations made for the purposes explained above.

These tests were made with a view of using the results obtained in planning experiments along the same lines but more elaborate in character.

It was not originally intended that they should be printed in bulletin form which will account for what may seem to be their brief and more or less incomplete form. It is intended that more complete experiments be made during the coming grinding season and outlines for such work will be found on another page. The tests recorded in the following pages were made by the writer, assisted by students in the Engineering Courses at the Louisiana State University.

Power Required to Operate a Cane Mill.

Of the total energy supplied in turning a cane mill, part is utilized in the production of useful work and part in overcoming friction. The latter is probably very nearly constant even with varying quantities of cane fed, provided the lubrication of bearings does not vary. The writer has not had the opportunity to verify this last statement by direct experiment, but takes it for granted from the fact that such has been found to be the case with steam engines. The friction of the mill consists of that at the journals and in the sliding contact of the large gear teeth, of which there are many. In addition to this a large quantity of work is lost in the friction at the turn plate, this being proportional to the feed. The horsepower required to do the useful work of grinding will depend upon the weight of cane fed in a given time; the condition of the cane whether crushed or not; the percentage of fiber in the cane, and the proportion of the juice that is extracted, this latter depending upon the pressure between the rolls; an increase of any one of these causing an increase in power required for a given tonnage.

It is evident therefore that in order to make comparisons of different mills as to the power required to run them, the unit of measurement of work done should include factors representing each. This of course would be a difficult matter. For instance there would be no way of measuring the thoroughness of preparation by the crusher and no way of insuring that the cane would reach the mill in like condition for any two mills. This would suggest that a better way of measuring power would be to measure that required to run the crusher and mill taken as a whole.

Cane with a large per cent of fiber will require the application of more energy for a given extraction than will a cane of less fiber for a given tonnage, because of the greater volume of the crushing mass and the resulting high pressures required at the rolls.

With reference to the question of extraction there are three methods of testing mill work; first the juice expressed, in per cent of the weight of the cane, usually termed "extraction." This is not a satisfactory basis of comparison because the "extraction" will depend entirely upon the original amount of juice in the cane. Second, the per cent, by weight, of moisture in the bagasse which is a better mode of comparison than "the extraction," but is misleading for the reason that it does not take into account the effect of maceration in varying the density of the juice left in the bagasse; third, "the volume of juice in the bagasse per unit weight of fiber in the bagasse." This last which is due to Mr. Noel Deerr is undoubtedly the only real test of mill work. For this determination in practice it would be necessary to obtain from samples of bagasse, the weight of juice, weight of fiber in a unit weight of bagasse, also the density of the juice in the bagasse. For example, suppose a sample of 100 parts of bagasse is found to contain 58 parts of juice and 42 parts of fiber, all by weight, the density of the juice being 1.38. Then $\frac{58}{42 \times 1.38} = 1.0007$ is the volume of juice in the bagasse per unit weight of fiber in the bagasse as stated above. The principal difficulty in applying this method would be in determining the density of the juice, so that the second method as stated above should be accurate enough for practical purposes. In the test recorded below no attempt was made to secure the data necessary for this determination, the principal object of the test being to get a general idea of the power required of the engine to operate a mill in a Louisiana plant, as well as the variation of the power with ordinary conditions of feed. The test consisted in taking the data necessary for determining the horse-power of the mill engine by means of an indicator, the formula for which is $\text{H. P.} = \frac{PLAN}{33000}$ in which P is the mean effective pressure, L the length of the stroke in feet, A the area of the piston in square inches, and N the number of strokes per minute. The observations taken during the test were, revolutions per minute, boiler pressure and indicator cards at regular intervals. These observations are recorded in columns 1 to 4 in table I.

The mill is of the six roller type manufactured by the Reading Iron Company and served by a Krajewski crusher. The mill rolls are 34x84 inches, geared so that with an engine speed of 50 R. P. M. the front mill rolls have a peripheral speed of 23.7 feet per minute and those of the back mill 25.5 feet per minute. A pressure of 330 tons on the front mill and 390 tons on the back mill is supplied by the hydraulics.

The top rolls were separated from the other rolls in the front mill so as not to touch, but those of the back mill were set "iron to iron." The cane is brought to the crusher by a carrier operated by the direct current motor, the speed of which may be varied by hand so as to regulate the feed to the crusher.

The mill engine is a 26x60 inch Corliss with a normal speed of about 50 R. P. M., and having a piston rod 5 inches in diameter. Indicator cards were taken every 15 minutes, or as nearly so as possible, with simultaneous readings of R. P. M., boiler pressure and time. The first four columns of table I contain this data. Column 5 of the same table gives the horse-power as calculated from the indicator cards by use of the formula explained above. During the test a carrier slat was broken, stopping the feed. Cards 5 and 6 were taken with the mill in motion, but with no cane feed, except for a few stalks passing when No. 5 was taken. Figure 1 is a sample head end card taken while the mill was feeding and Figure 2 with no feed.

TABLE I.

1 Time	2 Number of Card	3 R. P. M.	4 Boiler Pressure	5 H. P.
2:20 P. M.	1	50	100	238.7
2:25 P. M.	2	50	100	200.9
2:30 P. M.	3	50	98	181.0
2:45 P. M.	4	49	97.5	215.2
2:52 P. M.	5	35	101	37.2
3:00 P. M.	6	35	100	25.4
3:30 P. M.	7	50	101	201.1
3:45 P. M.	8	50	102.5	184.1
4:00 P. M.	9	50	102	239.9
4:15 P. M.	10	49	101	214.1
4:30 P. M.	11	50	101	211.2
4:45 P. M.	12	50	101	220.8
5:25 P. M.	13	50	98	169.8
5:45 P. M.	14	50	102	174.5
6:00 P. M.	15	50	100	184.9

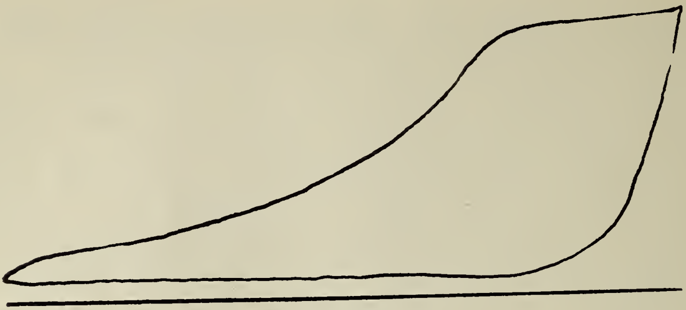

FIGURE 1.

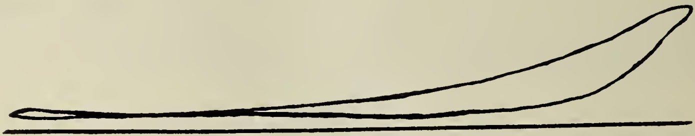

FIGURE 2.

From records of the mill for the day on which the test was made, the following data was obtained: Maceration, 5.04 per cent; fiber, 10.23 per cent; extraction, 76.63 per cent; cane mixed; density of juice, 13.9 Brix. On account of a breakage during the night the mill ran 18 1-3 hours during the 24 hours, the mill record showing a grinding of 901.53 tons during this time. This would be at the rate of 49.26 tons per hour or 1,180 tons per day of 24 hours.

RESULTS OF TESTS.

By reference to column 5 of Table I it will be seen that the power of the engine varies from a maximum of about 240 H. P. to a minimum of about 170 H. P. This gives a maximum of 34.3 H. P. per foot length of roll, or 29.0 H. P. per foot length per 1000 tons. The variation in power is caused by irregular feed due to the fact that the cane was unloaded from cars by mechanical means in such large quantities that it fell upon the carrier in bunches, the variable speed of the carrier being insufficient to correct it entirely. With steam at 100 pounds pressure this engine should develop about 320 H. P. It is, therefore, working considerably below its full capacity at this speed. It will be noticed that the speed was only 35 R. P. M. when card No. 6 was taken, the horse-power being 25.4. Since there was no cane passing this must represent the combined friction of the engine and mill. The mill friction consists of that of the main journals and the gear teeth, as well as that of the bagasse carrier which is run from the back mill.

It is reasonable to suppose that had the engine been making the normal 50 R. P. M. at this time that the power would have been increased in the ratio of 50÷35, which would run the friction up to about 36 horse-power. The friction of steam engines has been found by experiment to be practically constant for all loads, and it may be reasonably expected that the same would be true of a mill except for turn-plate friction, especially as the pressure of the hydraulics is removed only from the journals of the two lower rolls of the front mill when the feed is stopped. Taking 240, the maximum horse-power as the basis, the friction of both engine and mill amounts to only 15 per cent of the total. The friction of an engine of this type may be taken at about 10 per cent, which would leave only 5 per cent of the total indicated horse-power lost in mill friction. This is, of course, only approximate, but it shows that the friction of the mill is very small. It, however, takes no account of the friction at the turn plate, which is, in fact, a large source of power loss.

MAIN CANE CARRIER.

The object of this test was to get information as to the power required to drive a cane carrier operated by an electric motor of the direct current type. The power was measured by the use of volt meter and ammeter readings taken with instruments supplied from the electrical department of the Louisiana State University. The carrier supplies cane to the mill upon which the test recorded in preceding pages was made. The total length is 600 feet, and the vertical distance through which the cane is lifted is 27 feet, the cane being carried on the day of the test at the rate of 1180 tons per 24 hours or 49.26 tons per hour.

As already explained this motor is supplied with a starting box by means of which an attendant may vary the speed of the carrier so as to regulate the feed to the crusher; in other words, when a large bunch of cane is approaching the crusher the carrier's speed is reduced and vice versa. Readings of voltage and current were taken at intervals of one minute as shown in columns 1, 2 and 3 of Table II. The horse-power, column 4, was obtained by the well-known formula, H. P. $= \frac{\text{Volts} \times \text{Amperes}}{746}$

TABLE II.

MAIN CARRIER.

1 Time	2 Volts	3 Amp.	4 H. P.
1:30 P. M.	110	105	15.5
1:31 P. M.	111	62	9.2
1:32 P. M.	112	65	9.7
1:33 P. M.	112	66	9.9
1:35 P. M.	114	40	6.1
1:36 P. M.	110	70	11.0
1:38 P. M.	111	52	7.7
1:39 P. M.	109	68	9.9
1:40 P. M.	113	62	9.4
Average	111	65.5	9.8

Reference to Table II shows a maximum of 15.5 horse power and an average of 9.8 horse power, the former figure being that which would determine the necessary capacity of motor and the latter the average energy required to operate it. The average energy supplied to the carrier, therefore, is 9.8×33,000=323,400 foot pounds per minute. The useful work done in lifting the cane is 49.26×2,000×27 foot pounds per hour, or $\frac{2660040}{60} =$ 44338 foot pounds per minute. The efficiency, therefore, is $\frac{\text{Useful work}}{\text{Supplied work}} = \frac{44338}{323400} = .137$. In other words, 86.3 per cent of the work is used in overcoming friction.

CENTRIFUGALS.

Tests were made upon a set of four 30″ centrifugals of the '97 model Weston type, used for drying second sugars and a set of five 40″ Weston centrifugals used for drying first sugars, in order to obtain information as to the power required both for running and for starting. Both sets were of the belt driven type, the power for the centrifugals for seconds being supplied by a direct current electric motor through a main belt to a jack shaft, from which the individual centrifugals were driven by belts. The 40″ centrifugals were arranged in exactly the same manner except that the source of power was an automatic high speed engine.

The power required to run the motor driven set was obtained from current and voltage readings of the motor, as in the tests of the cane carrier. The power of a motor for running centrifugals is determined by that required in starting, due to the inertia of the heavy mass of sugar and basket. After the machine has reached its running speed no further energy is required except for overcoming the friction of the bearings and the resistance of the air. Both of these being very small in quantity. the power required to run the machine at normal speed is small. The power required to run the centrifugals alone was determined by getting the power required to run the main belt and jack shaft and subtracting the same from the total power to run the same with the centrifugals connected. In order to make the experiment as comprehensive as possible, both empty and loaded centrifugals were tested, both starting and running, the operating conditions being the same as for regular work.

Columns 1, 2, 3, 5 and 6 of Table III, contained the data taken during the test. As shown in column 1, there were several combinations of loading. The first horizontal line of the table contains the data taken with the jack shaft and conveyer running, the latter being belted to the shaft so that it could not be conveniently disconnected. This conveyer (empty) was therefore running during all the tests.

The second line, likewise, contained the data for one empty centrifugal, columns 2 and 3 giving voltmeter and ammeter readings for starting, and columns 5 and 6 for running at normal speed. To get these readings, the motor being in motion, the centrifugal was thrown in and the maximum reading of the ammeter needle noted, this reading and the corresponding voltmeter reading being taken as the data necessary for finding the power of starting and recorded in columns 2 and 3. The start having been made, the centrifugal was allowed to run until the ammeter needle came to a rest; this and the corresponding voltmeter reading being recorded in columns 5 and 6.

With one centrifugal in motion, the test for two empty centrifugals was made by simply starting centrifugal number 2, noting the maximum ammeter reading, etc., as before, and recording in columns 2 and 3, and 5 and 6. This gives the data, for both starting and running, for two empty centrifugals, one of which is running and the other starting. The next test was for three empty centrifugals, two of which were running and one starting, the other tests following in like manner.

The values given in column 4 were obtained by multiplying the values in columns 2 and 3 and dividing by 746.

The values in column 7 were obtained in a like manner from columns 5 and 6. The values in column 8 were obtained by subtracting 6.38, the horse power required to run the jack shaft and conveyor, from the corresponding values in column 4. The values in column 9 were obtained in the same manner from column 7.

RESULTS OF TESTS.

A comparison of columns 8 and 9 shows that the running power was very much less than the starting power, for instance, in the case of the single centrifugal, both empty and loaded, the running power was about 25 per cent of the starting power. The latter determines the capacity of the source of power though as it acts for a few seconds only, it does not represent the energy which has to be supplied by the boiler. The values in column 9, however, represent very nearly the average energy supplied. It will be noticed that the results are not altogether logical, though the irregularities are not greater than should be expected under operating conditions with varying tightness of belts and lubrication of bearings.

There is also a liability of a brake being accidentally thrown on, in fact, the large value of the next to the last item in column 8 was probably due to something of this kind.

CENTRIFUGALS DRIVEN BY A STEAM ENGINE.

The test mentioned on a preceding page of the set of 40" Weston centrifugals was planned to include the same scope as that of the motor driven set, the scheme for which is shown in Table III. The power was measured in this case by means of a steam engine indicator, using a No. 50 spring. The speed of the engine in revolutions per minute was obtained with a Starrett speed counter applied to the end of the engine shaft. A complete table similar in every respect to Table III was made out, but it was deemed inadvisable to include it here because of the fact that the results appeared to be so irregular as to be of little value. This irregularity was due to the fact that the speed counter could not be depended upon to indicate, accurately, the speed at the moment of starting. In other words, the instrument required several seconds time to get a reading, in which length of time there was a considerable variation of speed. The errors in speed caused corresponding errors in horse power. A tachometer will be procured for future tests.

Figures 2 to 5, inclusive, are head end indicator cards taken during the test. These may be taken as fairly accurate with respect to speed, and will give a good comparison of the power required to run one centrifugal under different conditions of operation, the horse power being proportional to the area of the card.

The engine was a 10"x20" automatic high speed, the speed being 140 R. P. M. for cards 3, 4 and 5, and 136 R. P. M. for number 6.

The card, figure 3, represents the power required to run the jack shaft with a screw conveyer 14" in diameter and 32 feet long, connected to it by belt. The power in this case figures 10.92 horse power. Figure 4 was taken with one empty centrifugal running, the power being 7.42 horse power. Figure 5 with one loaded centrifugal running, the power being 7.0 horse power; and figure 6 with one loaded centrifugal, starting, the power for which is 57.4 horse power.

It should be understood that the conveyor was running only when card No. 3 was taken. Unfortunatelly, the power required to run the jack shaft alone was not accurately deter-

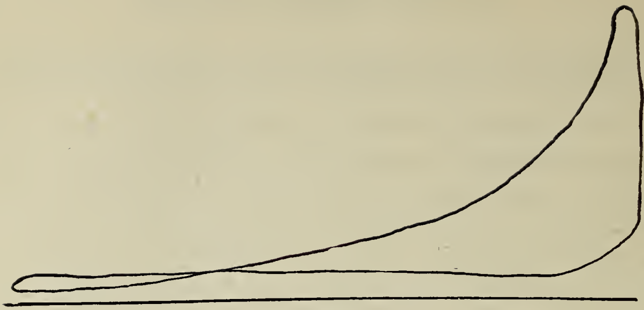

FIGURE 3.

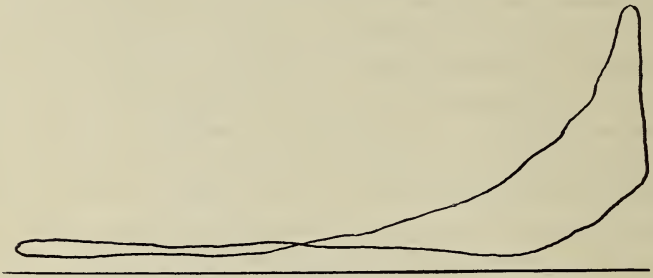

FIGURE 4.

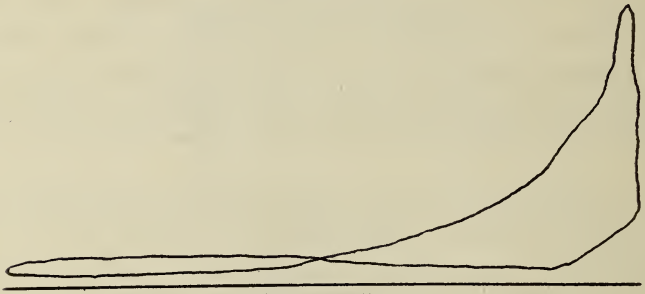

FIGURE 5.

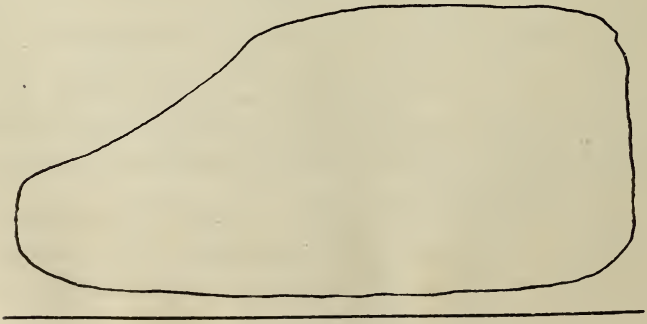

FIGURE 6.

mined, but as the friction of engines of this type is usually about 8 per cent of the rated capacity, it may be legitimately assumed that the friction of the engine, belt and jack shaft is about 8 plus 5, or 13 per cent of the rated power of the engine, which in this case is about 50 horse power. This will give 6.5 horse power, which is subtracted from 57.4, leaves 50.9 horse power, required to start the 40″ centrifugal.

TABLE III.

1	2	3	4	5	6	7	8	9
LOAD	One starting, with counter shaft and conveyor.		H. P., one starting, with counter shaft and conveyor.	Running, with counter shaft and conveyor.		H. P., running, with counter shaft and conveyor.	H. P., one starting, centrifugals only.	H. P., running, centrifugals only.
	Volts	Amperes		Volts	Amperes			
Counter shaft and conveyor..	....	....	....	119	40	6.38	.....	.....
One empty centrifugal	112	160	24	117	70	10.98	17.62	4.60
Two empty centrifugals	113	150	22.7	116.5	80	12.45	16.32	6.07
Three empty centrifugals....	111	180	26.8	116	90	14.00	20.52	7.62
Four empty centrifugals	110	170	25.8	114	100	15.3	19.52	8.92
One loaded centrifugal	112	140	21	117	65	10.2	14.62	3.82
Two loaded centrifugals.....	111	150	22.3	116	95	14.7	15.92	8.32
Three loaded centrifugals...	107	250	35.9	115	120	18.5	29.52	12.12
Four loaded centrifugals....	110	180	26.5	115	122	18.8	20.12	12.42

FUTURE EXPERIMENTS.

Other and more extensive tests will be made to determine the power required to operate crushers of different kinds, also the effect of turn-plate setting upon the power required to run the mill, using some such standard as that outlined on page 5, that will afford a means for just comparison of the work done by different mills. It is desirable also to make experiments that will throw further light upon the question of roll velocity and thickness of blanket and their effect upon the efficiency of crushing.

Centrifugals of the belt driven, water driven, and direct motor driven types will also be tested carefullly for the purpose of making comparisons as to the energy required to dry first, second and third sugars with each of these methods of driving. Investigations will also be carried on, as soon as practicable, to determine the relative capacities and efficiencies of different types of evaporators under different steam pressures. In this connection tests will be made to determine the actual increase of capacity due to increasing the pressure toward the end of the week's run, to overcome the effect of fouled heating surface. This has to be done at the expense of increased back pressure on all the engines of the house and the increase in capacity should be considerable to make its practice of actual profit.

Another ripe field for investigation is along the line of bagasse burning, including such questions as, bagasse burners, types and proportions of boilers, composition and temperature of chimney gases, heat value of bagasse, etc. In general it may be said that as rapidly as is practicable, this department will make more or less thorough experimental investigations into all the machinery of sugar houses.

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AGRICULTURAL EXPERIMENT STATION

OF THE

Louisiana State University
and A. and M. College,

BATON ROUGE.

A Preliminary Report

ON SOME

DISEASES OF CHICKENS

BY

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ASSISTANT VETERINARIAN AND BACTERIOLOGIST.

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SOME DISEASES OF CHICKENS

ENTERO-HEPATITIS OF CHICKENS

BY H. J. MILKS, D. V. M.

This disease has been known as fatal to turkeys for many years. It is characterized by thickening of the walls of the ceca or ''blind intestines'' and areas of degeneration in the liver.

Cause—In 1896 Dr. Theobald Smith described a micro-organism belonging to the protozoa as the cause of the disease and named it *Amoeba Meleagrides.* He found the parasite in 13 out of 18 cases examined. These parasites were circular, homogeneous bodies with sharply defined borders; within these and a little to one side of the center, was a group of granular bodies of a nuclear structure. They varied in size from 8 to 14 twenty-five-thousandths of an inch in diameter. Recently, several investigators have announced that the disease is really caused by a coccidium, but so far the writer has been unable to find a description of that organism.

Experiments show that the disease may be transmitted from one animal to another without the intervention of any intermediate host. The natural way of transmission probably is by the parasite passing out with the droppings of an affected bird and being taken up with the food and water of another.

History and Distribution—The disease was found in Rhode Island in 1894. More recently, Chester, of the Delaware Station, reported a similar disease of chickens. Indications are that it is quite widely distributed in certain of the New England States and in some of the Middle and Western States. It has not yet been reported from the South, though doubtless this is due to lack of investigation.

THE DISEASE IN CHICKENS.

In Louisiana the disease among chickens is evidently quite common. The writer has seen it in four quite widely-separated localities. The disease is confined almost entirely to young chicks. The writer has never seen it in birds more than six weeks old, and it is the general impression of owners that there will be no trouble with birds after six weeks to two months old.

The course of the disease is quite rapid, and the mortality, from thirty to fifty per cent of those hatched. The observations given in this bulletin are based upon the examination of seventeen chicks.

Symptoms—There were no well-marked symptoms peculiar to this disease. In some cases death occurred during the night with no previous signs of sickness. In others there was dullness, stupor, and loss of appetite. Diarrhoea may, or may not, be present. Unless the course of the disease was very rapid, emaciation was marked. Usually the course of the disease was very rapid, lasting not more than a day or two after the appearance of the first symptom. Occasionally one would linger along for four or five days.

Post Mortem Appearances—By post mortem examination the disease was not hard to determine. The ceca, or two blind tubes opening into the intestine, were first attacked. These were very much enlarged and presented a grayish, roughened exterior. The walls were much thickened; mucosa necrotic or detached. They were generally filled with a hard coagulated material, yellowish in color and quite firm. Upon removal of the contents, they remained a cast of the organ.

If the course of the disease was not too rapid, secondary lesions were found in the liver. The areas of disease in this organ were generally circular in outline, though some were irregular and some confluent, grayish or yellowish-white in color. Some even showed a dark center with light periphery. These areas varied in size from one or two millimeters to as many centimeters in diameter. The coloration was not so brilliant, nor was the liver appreciably enlarged, as is the case with turkeys. Fig. 1 shows the diseased liver and ceca of a chick.

Other organs were usually normal, though there was occasionally congestion of the kidneys and spleen. The ureters were usually filled with white urates.

Microscopic examination of sections of the diseased ceca showed the walls much thickened. Purulent infiltration was marked throughout the mucosa and submucosa. Much of the mucosa was usually detached; blood vessels congested. In the mucosa and submucosa were many parasites occurring singly or in groups. Occasionally they were found in the inner muscular layer. The organisms were surrounded by a connective tissue reticulum and seemed to take the place of normal tissue. (Fig. 2.)

Sections of a diseased portion of the liver showed that in the center of these areas the liver cells had almost entirely disappeared, their place being taken by the parasites in a reticulum of connective tissue (Fig 3). The blood vessels were congested. Giant cells, which are so numerous in the diseased organs of turkeys, were almost lacking in the chick.

Description of the Organism Found in Chickens—This organism is undoubtedly closely related to, if not identical with, the organism described by Smith.

In fresh preparations of scrapings from the walls of the ceca, highly refractive bodies, finely granular, or homogeneous in structure and circular in outline, were found. In stained preparations they do not take the ordinary amoeba stains well, but do stain well with Mallory's Chloride of Iron Hematoxylin. With this preparation they stain quite evenly except for a number of vacuoles present. With Oliver's modification of Wright's stain, they take the eosin well. Usually with this method, a small pale blue nucleus was found a little to one side of the center. It was found that if the preparation was made by diluting the scrapings with water or normal salt solution and allowing a small drop to dry on a clean cover, the organisms were usually circular in outline, while, if smeared upon the glass, they were irregular in shape. Fig. 4 is from a microphotograph of one of these smears stained with Chloride of Iron Hematoxylin.

In sections, the parasites appeared as circular bodies, staining feebly. Within these, and a little to one side of the center, a very small darker stained nucleus was usually seen. In the tissues they were surrounded by a connective tissue reticulum and with this appeared to take the place of normal tissue.

Size—In smear preparations their average size was 10.8 microns, while in sections it was from 6.8 to 12 microns in diameter (average 8). No measurements were made of fresh preparations.

A complete description of a typical case will be given. A summary of all the cases will be found in Table I.

Case 1—Plymouth Rock chick, about one week old, had been sick two or three days.

Autopsy—Respiratory system normal. Subcutaneous tissue and peritoneal cavity contained an abundant clear yellow fluid. Crop normal. Small intestines slightly congested along the pancreas. Both ceca much enlarged and hard, filled with a dry coagulum or exudate which, upon removal, remained a cast of the organ and had a tendency to take the mucosa with it. The right cecum grayish white and roughened externally. The left, smooth, dark in color and more normal in appearance.

In the liver extensive lesions were found; fully two-thirds being taken up with grayish white or yellowish areas. For the most part these were circular in outline, though some were irregular. In some places they consisted of a dark center with light periphery. They varied in size from one to two millimeters to as many centimeters in diameter. Fig. 1 is from a photograph of the liver and ceca of this chick.

Microscopic Examination—Ceca: Mucosa detached. Purulent infiltration throughout the section, especially marked in the mucosa and submucosa. Blood vessels congested. Many parasites were found in the mucosa and submucosa. These were surrounded by a reticulum of connective tissue. A few were seen in the inner muscular layer.

TABLE I, SHOWING SUMMARY OF EXAMINATION OF CHICKS.

No.	Source	Age	Diseased Ceca	Diseased Liver	Parasites in	
					Ceca	Liver
1	Baton Rouge	2-3 weeks	Both diseased	Very extensive	Numerous	Numerous
2	Baton Rouge	2-3 weeks	Both diseased	Slight	Numerous	Numerous
3	Exp. Farm	1 week	Both diseased	Normal	Fair	Numerous
4	Baton Rouge	3 or 4 w'ks	Both diseased	Slight	Fair	Not examined
5	Exp. Farm	1 week	Both diseased	Normal	Numerous	Numerous
6	Exp. Farm	1 week	Both diseased	Slight	Numerous	Numerous
7	Geismar	1 week	Slight in right	Slight	Fair	Fair
8	Geismar	4-5 days	Both	Slight	Fair	None
9	Geismar	4-5 days	Normal	Normal	Fair	None
10	Geismar	1 week	Slight	Normal	Fair	None
11	Geismar	1 week	Normal	Normal	Fair	None
12	Geismar	1 week	Slightly	Normal	Numerous	None
13	Moreauville	3-5 days	Both	Extensive	Not examined	Not examined
14	Moreauville	1 week	Both	Extensive	Not examined	Not examined
15	Moreauville	2 weeks	Left slightly	Slight	Not examined	Not examined
16	Moreauville	2 weeks	Both	Extensive	Not examined	Not examined
17	Exp. Farm	3-5 days	Right slightly	Moderate	Not examined	Not examined

Treatment and Prevention—No work was done with regard to treatment and prevention of the disease. Feeling, however, that something should be said in this connection, the measures recommended in Circular No. 128 of the Bureau of Animal Industry will be given.

Treatment is not very satisfactory. An attempt might be made by the use of calomel, one-tenth of a grain, or a few drops of castor oil containing one or two drops of turpentine. Also 5 to 10 grains of iron sulphate should be dissolved in each gallon of drinking water.

The most successful method of combatting this disease is prevention, and even this is not satisfactory. The eggs should be cleansed by wiping them thoroughly in 95% alcohol. If an incubator is used it should be wiped out with some antiseptic and exposed to the sun. The egg tray should be scalded. The floor of the nursery should be movable, so that it may be sterilized, and, if made of burlap, the old piece should be removed and a new one attached to the disinfected frame. The brooders should be cleansed in the same way. The soil to which the chicks have access should be well limed, dug up and exposed to the sun.

If natural incubation is practiced, the hen for a week or more before being set should be dosed with one-fourth to one-half grain of iron sulphate daily and an occasional purgative, such as one grain of calomel or one-half teaspoonful of castor oil to which has been added five or six drops of turpentine.

The eggs, after treating as above, should be placed in a clean nest, which may be sprinkled occasionally with lime. After hatching, the hen with her chicks should be placed upon ground, treated as above, and moved frequently to new ground, treated in the same manner, and from which chickens have been debarred.

REFERENCES.

Chester—Report of bacteriologist, Del .Sta. Agr. Exp. Station, 1899-1900.

Moore—The Direct Transmission of Entero-Hepatitis of Turkeys, Cir. No. 5, Bureau of Animal Industry.

Moore—Pathology of Infectious Diseases of Animals.

Smith—Infectious Entero-Hepatitis of Turkeys, Bul. No. 8, Bureau of Animal Industry.

A BACTERIAL DISEASE OF YOUNG CHICKS.

In the early part of January, 1907, our attention was called to a very fatal disease of young chickens. A few days later a few chicks were brought to the laboratory for diagnosis.

History—The owner of the affected flock had started in the poultry business several months previous on a rather extensive plan. His incubator capacity was so great that he was using eggs from every available source. During the previous few weeks about 1,500 chicks, or between 50 and 60 per cent, of these hatched. The chicks were given good attention. The feed and sanitary conditions were considered good. None of the neighbors had reported any trouble with their chickens.

The disease was entirely confined to young chicks under five or six weeks old.

Symptoms—The course of the disease was so rapid that many chicks died during the night without previously having shown any signs of illness. Others showed dullness and stupor. Diarrhoea was present in some cases. In these cases the appetite was inpaired or entirely lost; weakness was often so marked that for several hours before death the bird would lie in a comatose condition.

Post Mortem Appearances—Post mortem appearances were not marked but, as a rule, quite uniform. The digestive tract was normal in nearly all cases; the liver constantly enlarged, dark in color and engorged in blood; gall bladder usually filled with dark bile and ureters with white or yellowish waters; lungs normal in all cases.

The heart was filled with blood; its external blood vessels usually congested. In one case grayish-white areas from one to two millimeters in diameter were upon its exterior.

Microscopic Appearances: Small Intestine—Section from a congested area showed marked inflammatory conditions. Blood vessels congested, numerous polymorphonuclear leucocytes were found in the mucosa and submucosa. Many were also present in the blood within the blood vessels and even passing through their walls.

A few of the cells of the mucosa showed degeneration, but no necrosis could be found.

Liver—This organ gave the most pronounced lesions. The blood vessels were much congested and the red blood cells were scattered throughout the section. So many red cells were present that they gave the appearance of crowding the rows of liver cells out of place. Some granular degeneration of the liver cells was also seen. These appearances were constant in all cases examined.

Bacteriology—Cultures were made from the liver and heart blood of the chicks. From four (4), pure cultures of bacillus coli were obtained; from six (6), a different organism was obtained. The bacteria were few in number, since they could only be found with difficulty in cover glass preparations, and agar-streak cultures from a loop of blood after 24 hours, usually gave separate colonies.

Technique—The ordinary bacteriological technique was used. The media was made from beef and rendered 1.5 acid to phenolphtalein. The bouillon was rendered sugar-free with B. coli, then pepton and salt added. One per cent of the different sugars in sugar-freed bouillon was used to test the fermentative properties. The indol test was made in five-day cultures by the contact method. Gram's stain was made from 24-hour-bouillon and agar cultures.

DESCRIPTION OF THE ORGANISM.

Morphology—Small rods with rounded ends 1.3—1.8×.5—.7 microns non-motile but with marked Brownian movement. It does not form spores. Usually it stains uniformly with the common dyes, though in some cases a polar stain is seen. It is decolorized by Gram's method. It is aerobic and facultative—anaerobic; grows best at 37° C., and feebly at room temperature.

Cultural Characteristics: Bouillon—This medium becomes strongly uniformly-cloudy in 24 hours with a white sediment. The reaction remains alkaline throughout but becomes more alkaline after 10 to 14 days.

Agar—Raised, moist, regular growth. Pearly white by transmitted light; dull white or smoky by reflected light.

Gelatin—Is not liquified. The growth is feeble and regular along the middle tract, very slightly spreading on the surface.

Gelatin colonies are yellowish-white, circular with sharply defined edges, finely granular.

Potato—At first a whitish growth, later a yellowish moist growth. The potato is not affected. Often no growth appears on this medium.

Milk—This medium remains unchanged for about two weeks, then becomes more alkaline and is saponified. Boiling does not precipitate the caesin but acetic acid throws it down as a heavy white precipitate.

Litmus Milk—This reacts the same as milk except that the color becomes a deep blue.

Sugar-Free Bouillon—Same general appearance as bouillon. Indol is not produced.

Glucose Bouillon—The medium becomes acid with the production of gas.

Lactose Bouillon—No gas. Culture remains alkaline.

Saccharose Bouillon—No gas. Culture remains alkaline.

Levulose Bouillon—Reaction acid with production of gas.

Mannite Bouillon—Reaction acid with production of gas.

Thermal Death Point—Bouillon cultures resisted boiling for 15 minutes.

Effect of Disinfectants—One per cent of carbolic acid failed to prevent growth after 15 minutes; after 17 minutes no growth appeared. Two per cent carbolic acid prevented growth after 2½ minutes.

The method employed was to add 5 drops of a 24-hour bouillon culture to five cc. of the disinfectant. The mixture was well shaken and subcultures made in bouillon at intervals of 2½ minutes up to 17 minutes. The subcultures were incubated for 5 days at 37° C.

Pathogenesis: Chicks—One-fourth cc. of a 24-hour bouillon culture of the organism was introduced subcutaneously into two chicks. One died in 6 days without showing any signs of illness. The other was sick a few hours before death; was stupid and weak. No rise of temperature occurred; died in 21 days. The organism was recovered from both chicks.

Two other chicks were given milk to which a 24-hour bouillon culture of organism was added. They remained perfectly normal as far as could be determined. After 6 weeks they were killed and post mortemed. No evidence of disease was then found.

Mice—Mice were inoculated subcutaneously with $\frac{1}{4}$ cc. 24-hour bouillon culture. One died in 20 days with septicaemic lesions and the organism recovered from the liver. The other two survived and showed no effect of the inoculation except abcess formation at the point of inoculation.

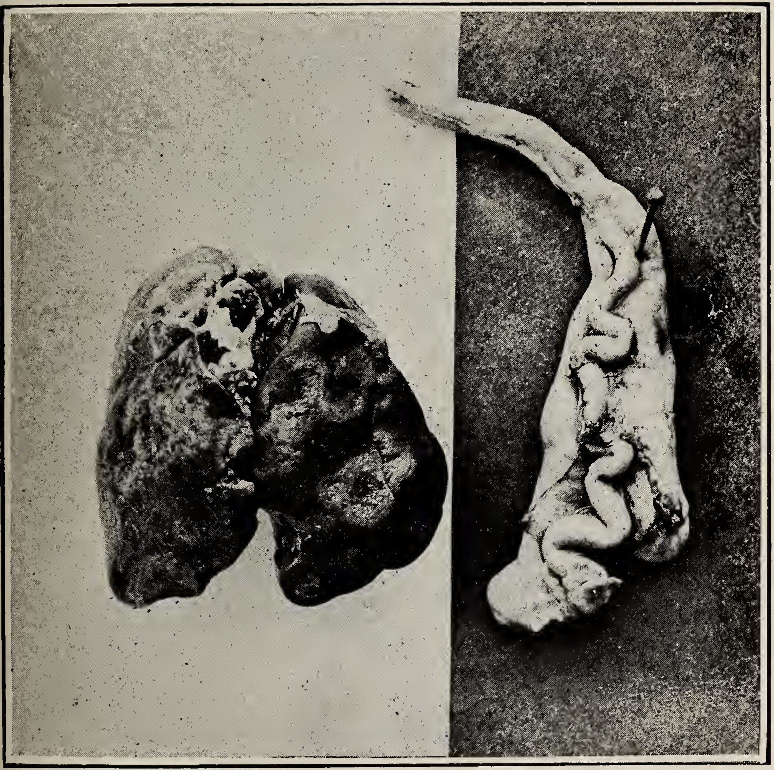

FIG. 1.—Liver and ceca of chick, showing diseased conditions found in Entero-Hepatitis of chickens.

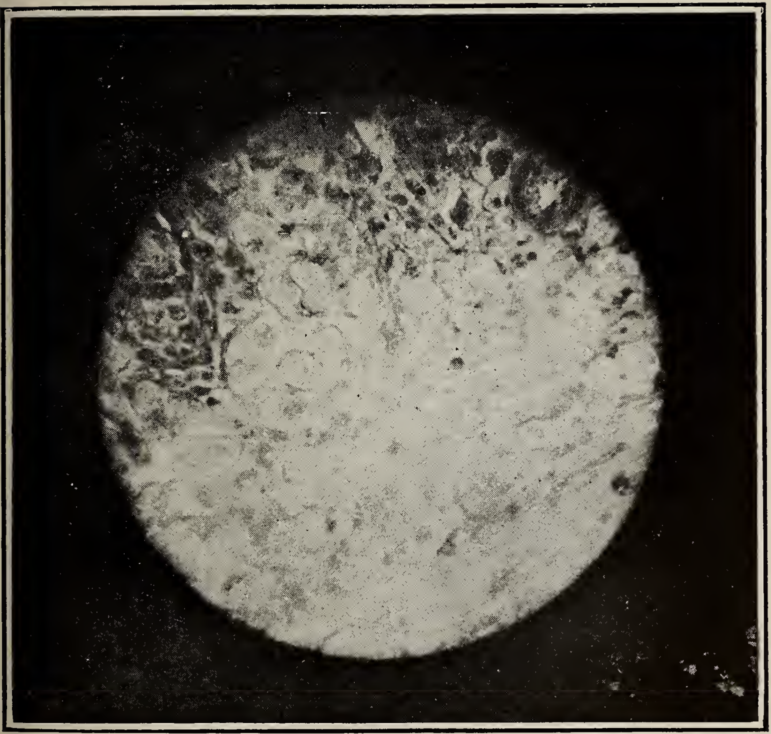

FIG. II.—Photomicrograph of diseased cecum of chick, showing the parasites.

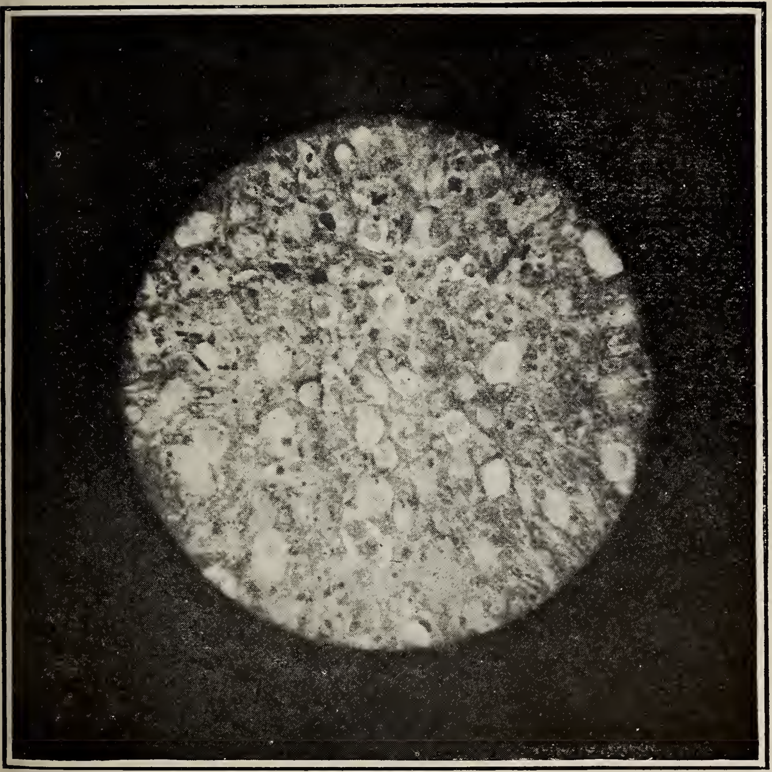

FIG. III.—Section of diseased liver, showing the parasites.

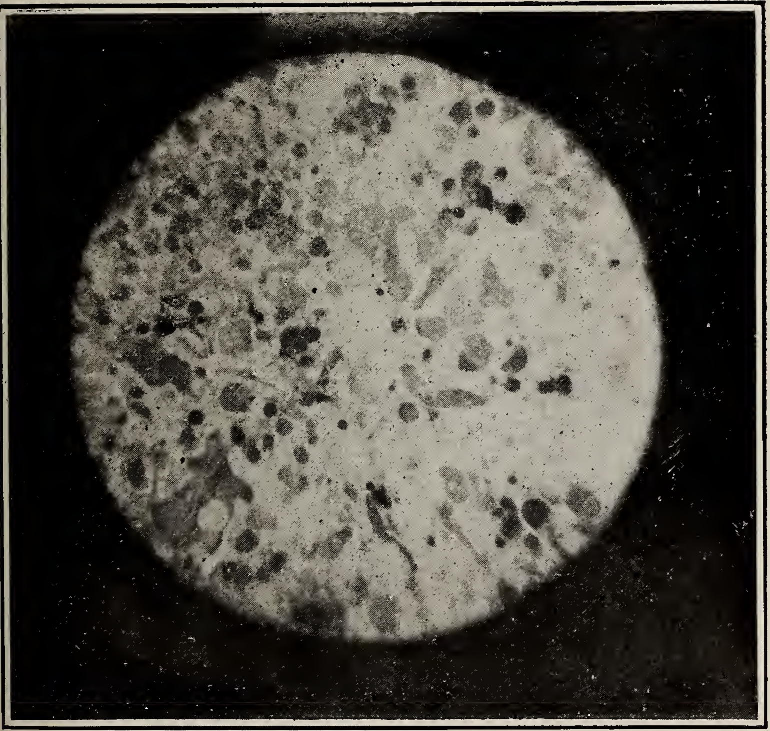

FIG. IV.—Organisms found in smear preparations.

W. E. Joseph

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AGRICULTURAL EXPERIMENT STATION

OF THE

Louisiana State University
and A. and M. College,

BATON ROUGE.

Experiments with

BACTERIUM ANTHRACIS, ANTHRAX VACCINES AND HYPERIMMUNIZATION.

BY

H. J. MILKS, D. V. M.

ASSISTANT VETERINARIAN AND BACTERIOLOGIST.

BATON ROUGE:
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PREFACE.

BY W. R. DODSON, DIRECTOR.

The material for this bulletin was prepared for publication by Dr. Milks as his last work before leaving Louisiana to accept a more flattering offer elsewhere. As originally prepared, a general discussion of the subject of anthrax preceded the report of the experiments conducted by Dr. Milks. Partly from a lack of funds for publication, and partly from consideration of the fact that previous publications of this station have dealt with most of the known characters of the disease, the first part of the report has been omitted, and I have asked Dr. W. H. Dalrymple to prepare a synopsis of the leading facts regarding the disease, as an appendix to this report. The report here given deals with investigations carried on in three lines:

1. Investigations as to the probability of decaying vegetable matter in fields and pastures furnishing nutritive material for the growth of anthrax organisms, and the perpetuation of the disease thereby.

2. Investigations as to the reliability and value of vaccines, and the comparative merits of the methods of preventive vaccination now available to the planter.

3. Investigations as to the possibility of producing a superlative degree of immunity by continued vaccination of increasing severity, and the possible value of serum of hyperimmunized animals as an aid to hastening immunity, or as a curative agent.

It is to be regretted that the work has been interrupted, but it has been deemed best to publish the results thus far obtained, as a report of progress. Those interested in the subject will find here some valuable data. The results clearly indicate the necessity of some means of gauging the quality of vaccines on the market, or that some branch of the State government should prepare and distribute vaccines of known virulence, when the use of vaccine is deemed advisable.

W. R. Dodson, *Director.*

ANTHRAX.

BY H. J. MILKS, D. V. M.

Of all the infectious diseases in this State, Anthrax, or Charbon, is undoubtedly the most dreaded among stock owners. There are several large areas in the State where the disease is liable to break out at any time, and the mortality is always high.

Cause or Etiology—Charbon is caused by a very minute organism, Bacterium anthracis, a rod-shaped germ, which is found in the blood and diseased tissues of animals suffering, or that have died from the disease. These organisms are so small that it takes 650 to 2,500 of them placed end to end to make an inch. In the presence of oxygen they form spores which are very difficult to destroy. To this is due the difficulty of stamping out the disease. According to Koch, anthrax bacteria grow readily upon potato, infusions of hay, mashed barley, mashed wheat, pea straw and numerous other substances, when sufficient moisture is present. The writer made an attempt to grow the organism upon different media liable to be found in pastures, results of which are here given.

The material from which the medium was to be prepared was placed in a glass dish, distilled water added and the material allowed to rot. Agar medium was then made from the infusion, using 1% agar, sterilized in the usual way. In case of the dung agar, the material was used fresh, before it had fermented. The inoculations were made from an old culture containing nothing but spores.

Clover Agar—A good visible white growth appeared after six hours. At this time stained preparations showed typical spore-forming Anthrax bacteria.

Crab Grass Agar—No evidence of growth could be found. Only a few spores were seen in stained preparations. These were evidently those used for inoculation.

Cow Dung Agar—At the end of 36 hours a visible white growth appeared. Cover-glass preparations showed spore-forming Anthrax bacteria.

Distilled Water Agar—Upon this medium, growth was slow. After two days, however, a distinct growth could be seen.

SOLID MEDIA—In the next series green material was placed in sterile test tubes and a few drops of sterile distilled water added, then sterilized and inoculated with spores. Three tubes were used, except in case of the bean, where two were used. The inoculations were made in the water and on the surface of the material when sufficient place was present to be identified. The bean was inoculated along the surface.

String Bean—In each case at the end of 24 hours a white growth appeared on the surface, and the water became cloudy. The growth increased for three or four days. In the meantime the water became more cloudy and the bean darker yellow in color. Stained preparations showed spore-forming Anthrax bacteria.

Alfalfa—Two out of three tubes gave feeble growth, manifested by a cloudiness in the water and in stained preparations. In the third tube no growth took place.

Bermuda Grass.—All three tubes showed slight cloudiness at the end of 24 hours. This increased for several days. Coverglass preparations showed Anthrax bacteria in 24 hours and spores after 48 hours.

Vetch—No visible growth at 24 hours, but smears showed numerous Anthrax bacteria. After 48 hours a slight white growth became visible on different parts of the medium. These proved to be Anthrax organisms. The water also became cloudy after 48 hours. Spores were found at 48 hours.

Clover—Slight cloudiness in all three at 24 hours. After 48 hours a good white growth could be easily seen on different parts of the leaves. Spore formation also was taking place at this time.

Crab Grass—No growth on any of the media.

It can readily be seen how these organisms propagate outside the animal body under certain conditions, namely, heat, moisture and nutritive material. The proper nourishment is available nearly everywhere.

This experiment also points out that Anthrax bacteria without doubt will grow in low, swampy places and even in any place where sufficient moisture is present. If this holds true, then, aside from the organisms excreted by animals, we may have millions more to fight that have come from the multiplication of those excreted. This possibly may explain why we have certain charbonous years, in which careful observers may, with some certainty, predict an outbreak of the disease; that is, years in which we have frequent showers, followed by hot weather, or a long, hot, dry spell followed by showers. The organism may be present in the soil. Ideal conditions come for its development; large colonies may be carried up by vegetation to the point where an animal may take it in with food, or these organisms may be washed to some watering place and taken in with water.*

PROTECTIVE INOCULATION OR VACCINATION.

Three methods of vaccination are available—the Pasteur, the Simultaneous, and with Axthraxoids prepared by Parke, Davis & Co. According to the Pasteur method, two inoculations or injections are necessary. Both vaccines are attenuated or weakened cultures of Anthrax bacteria. No. 1 is weaker than No. 2 and is injected first. No. 2 is injected after about twelve days. The vaccines must be fresh and properly cared for.

No. 1 is so weak that in sufficient doses it will only kill white mice, and not guinea pigs; while No. 2 will kill guinea pigs, but not rabbits. The attenuation or weakening is secured by growing the organisms at 42°-43° C. for a certain number of days.

A high degree of immunity is supposed to result from such a vaccination. This is of short duration, however, even the manufacturers advising that immunity will last only about one year. In France, by this method, Anthrax has decreased to a large extent. Chester and Neal of the Delaware Station have shown good results with this method. In England and Germany the results with Pasteur vaccine have not been so good. It was found that the first vaccines as a rule were harmless, but that No. 2, even in the hands of experts, is often dangerous and fatal.

There are several vaccines on the market presumably made after the Pasteur method. These are Pasteur's Anthrax Vaccine Virus, in amber tubes, for sale by Sorby Vaccine Company; Pasteur's Anthrax Vaccine, in blue tubes, for sale by Pasteur Vaccine Company. Each claim theirs to be the genuine Pasteur vaccine. Besides these we have Mulford's Anthrax Vaccine and Cutter's Anthrax Vaccine, made in this country and probably along the same lines.

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*When this subject is again taken up, the influence of weather conditions and source of nutritive material on the virulence of the organism will be investigated. (Director.)

There are several disadvantages to the use of vaccines:

1. The vaccine may be too strong and not only kill the animal inoculated, but start a new outbreak of the disease.

2. The attenuation may be carried too far, so that it is worthless.

3. A vaccine consisting of attenuated organisms may become more attenuated with age, so that even if of the proper strength when prepared, may be worthless when used. The writer has noticed that it is with difficulty the virulence of the organism can be kept up even when passed through an animal occasionally. This matter of attenuation should be recognized and a safe time limit placed upon each package. Until recently this was not done, but now most vaccines are so labeled and the purchaser should see to it that old goods are not supplied to him.

With all its disadvantages it must be admitted that Pasteur's vaccine has done a great deal of good against the disease in Europe and even in our Southern States, though in this connection it must be borne in mind that the spreading of the knowledge concerning the specific organism and proper hygienic measures have aided in suppressing the disease.

In England the stamping-out system is preferred to vaccination. According to Crookshank it is regarded as the only reliable means of suppressing the disease.

The Simultaneous method, or Sero-vaccine, consists of the injection of Anthrax antitoxin with a small quantity of virulent anthrax bacteria. By using the serum or antitoxin it is believed that a stronger culture may be used. It has the advantage of being administered at one time. This vaccine has been little used in this country, but good reports of it come from South America.

Anthraxoids are little pellets or granules to be injected under the skin with a special injector. They are supposed to contain dead anthrax germs. Very little data is available regarding this product, but some report good results from its use.

Several experiments have been made as to the virulence of different anthrax vaccines and will be taken up in the order in which they were made, so as to get exactly similar conditions.

EXPERIMENT No. 1.

This was made upon vaccines obtained from the Pasteur Vaccine Company October 27, 1906. No time limit was placed on the product nor advice given regarding its use upon sheep and goats. Mulford's vaccine, obtained from H. K. Mulford Co. October 25, 1906. This was labeled not to use after November 14, nor upon sheep and goats. As we wished to get some data as to the time limit of these goods they were used November 26, 1906. On this date a mouse and a guinea pig each received 1/10 cc. of Pasteur No. 1. Another mouse and pig received 1/5 cc. of Mulford's No. 1. All animals survived. At the same time the above animals were inoculated, a tube of agar was inoculated with one loopfull of each of the vaccines. The tube inoculated from Pasteur's vaccine at the end of 24 hours, contained 20 small circular colonies. These did not much resemble anthrax colonies, but stained preparations gave typical anthrax organisms. The tube inoculated from Mulford's vaccine remained sterile. November 28 a second tube was inoculated from Mulford's culture. After 24 hours several colonies similar to those obtained from the Pasteur tube were present. These also showed typical anthrax in stained preparations. After two or three generations upon agar, both cultures had more the appearance of anthrax colonies.

November 28 two mice were inoculated. One received a loopfull of the growth scraped off agar from Pasteur's vaccine and the other the same amount from Mulford's vaccine. Both survived.

More work was not undertaken owing to the difficulty of obtaining experimental animals. It seems, however, that both vaccines were too much attenuated or the time of their usefulness had ceased.

EXPERIMENT No. 2.

This was made with Pasteur's vaccine, obtained December 8, 1906. December 10, inoculated two agar tubes with No. 1. In 24 hours the tubes showed 9 and 60 minute round colonies, very little suggestive of anthrax. However, stained preparations showed them to be typical anthrax.

Dec. 11. Mouse No. 1 received 1 loop agar growth off tube of 9 colonies.

Dec. 11. Mouse No. 2 received 1 loop agar growth off tube of 60 colonies.

Mouse No. 1 survived. No. 2 died in six days. Autopsy showed little enlargement of the spleen. Stained preparations from spleen gave typical anthrax organisms; cultures gave anthrax-like growth.

Dec. 18. Inoculated mouse with 1 loop agar culture from mouse. Mouse died in 6 days. Appearances same as in preceding case. Dec. 27, culture from above mouse showed typical anthrax, with an abundance of spores.

Dec. 28. Inoculated guinea pig with 1 loop of above. Pig recovered.

Dec. 16, 1906. Inoculated two agar tubes with a loopful of Pasteur No. 2. In 24 hours there were 36 colonies on one, and 51 on the other. These somewhat resembled anthrax colonies. Stained preparations showed them to be anthrax.

Dec. 17. Inoculated mouse and guinea pig with 1 loop of above culture. Mouse died in two days. The organism was recovered from spleen. The guinea pig survived.

Mulford's. Just Received.—Jan. 3, inoculated agar with No. 1 and No. 2. Jan. 4, inoculated mouse and pig with one loop of culture from No. 1. Both survived. Jan. 4, inoculated mouse and pig with one loop of culture from No. 2. Mouse died in two days. Anthrax in spleen. Guinea pig survived.

In the above experiment Pasteur's No. 1 seemed of about the right degree of virulence. No. 2 was too much attenuated. Mulford's No. 1 and No. 2 seemed too attenuated to be of value.

EXPERIMENT NO. 3.

Pasteur's Vaccine. Just received.—This vaccine was to be used upon some sheep. It was tested upon small animals as shown in the following table. All animals were inoculated from a 24-hour agar culture of the original culture.

TABLE I.

Date	Animal	Dose	Source	Results	Remarks
Jan. 19	Mouse	1 loop. 24 hr. Agar culture	Past. No. 1	Died 4 days	Few Anthrax bacteria in spleen
Jan. 19	G. Pig	"	Past. No. 1	Survived	Showed no signs of illness
Jan. 31	Mouse	"	Past. No. 2	Died 2 days	Many Anthrax bacteria in spleen
Jan. 31	G. Pig	"	Past. No. 2	Died 3 days	Few Anthrax bacteria in spleen
Jan. 31	Rabbit	"	Past. No. 2	Survived	Showed no signs of sickness

EXPERIMENT No. 4.

Test of value of Pasteur's vaccine, and anthraxoids, on sheep. Four adult sheep in good condition were used. Pasteur's vaccine was the same as that tested in preceding table and showed proper theoretical strength.

TABLE II.

No.	Date	Vaccination	Results	Remarks
1	Jan. 18	Pasteur's No. 1	Survived	
2	Jan. 18	Pasteur's No. 1	Survived	
3	Jan. 18	Anthraxoid	Survived	
4	Jan. 18	Anthraxoid	Survived	
1	Jan. 30	Pasteur's No. 2	Died Feb. 9	Anthrax bacteria numerous in peripheral blood
2	Jan. 30	Pasteur's No. 2	Survived	
2	Feb. 21	*$\frac{1}{10,000}$ loop	Survived	Cultures found to have become attenuated so that they were of about equal virulence with Past. No. 2
3	Feb. 21	$\frac{1}{10,000}$ loop	Survived	
4	Feb. 21	$\frac{1}{10,000}$ loop	Survived	
2	Mar. 9	$\frac{1}{10,000}$ loop	Survived	This culture also had lost much of its virulence
3	Mar. 9	$\frac{1}{10,000}$ loop	Survived	
4	Mar. 9	$\frac{1}{10,000}$ loop	Survived	
2	Mar. 22	†$\frac{1}{10,000}$ virulent	Died Mar. 26	Swelling at point of inoculation. Organisms in blood culture very virulent
3	Mar. 22	$\frac{1}{10,000}$ virulent	Survived	
4	Mar. 22	$\frac{1}{10,000}$ virulent	Survived	
3	Apr. 9	$\frac{1}{1,000}$ virulent	Died April 11	Many Anthrax bacteria in blood
4	Apr. 9	$\frac{1}{1,000}$ virulent	Survived	
4	Apr. 25	1-500 virulent	Died April 30	Many Anthrax bacteria in blood

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*It was found by a series of plate culture 1-10,000 loop of agar culture contained from 352-470 organisms Average 408.

†This culture was used for remaining inoculations. Simply grown for 24 hours upon agar before use.

It will be noticed from the preceding table that sheep No. 1, vaccinated with Pasteur's vaccine, died from the effects of the second vaccine, while No. 2, which stood this vaccine and even a couple more doses of an organism of about the strength of Pasteur No. 2, died four days after receiving a very minute dose of a virulent culture.

It would seem that a vaccine strong enough to kill one animal ought to be strong enough to protect those that survive. In this case at least it did not.

Sheep 3 and 4, vaccinated with anthraxoid, behaved somewhat better, but even these showed the difficulty of getting positive results from any vaccination. Both of these animals stood both doses of the weakened culture and 1/10,000 loop of the virulent culture. Eighteen days later No. 3 died, after receiving 1/1,000 loop of the same organism. The last animal died about two weeks later after 1/500 loop of the same organism.

A further experiment was made along the above lines with much better results. Three sheep were used. One vaccinated with anthraxoid and two with Pasteur's vaccine.

April 16, '07. Vaccinated No. 1 with anthraxoid.
April 16, '07. Vaccinated Nos. 2 and 3 with Pasteur's No. 1.
April 29, '07. Vaccinated Nos. 2 and 3 with Pasteur's No. 2.

All animals survived the vaccination and were inoculated as follows: All received the same dose and were kept under the same conditions. The culture used for vaccination was the virulent one used in the preceding experiment with sheep.

May 16	1/10,000 loop agar 24-hour culture
June 2	1/4,000 loop agar 24-hour culture
June 18	1/1,000 loop agar 24-hour culture
July 4	1/500 loop agar 24-hour culture
July 22	1/166 loop agar 24-hour culture
August 5	1/50 loop agar 24-hour culture
*August 20	1/50 loop agar 24-hour culture

*It was noticed that the culture had become weakened, so it was passed through a guinea pig and the dose repeated.

It will be noticed that all the sheep survived this experiment. The object in repeating the dose and increasing it so slowly in these sheep experiments was to get a high degree of resistance and, if possible, a serum with some antitoxic value. These animals were given up after August 5, as we then had some animals that had survived an experiment in which a much larger dose was given.

In the next experiment 20 sheep were used. They were vaccinated as follows:

Five with Pasteur's No. 1, July 11, '07, and with No. 2 July 24.

Five with anthraxoids, July 11, 07—five with sero vaccine (Merck).

Five unvaccinated controls.

August 12 all were given 1/2 loop of agar culture in sterile water inside of thigh. Table III shows results of this experiment. In each lot it will be noticed all had marked fever reaction. The controls not showing any more marked reaction than those vaccinated. It will also be noticed that the same number (1) died from those vaccinated with Sero-vaccine, anthraxoids, and the controls. Two, however, died from the Pasteur lot. This is misleading, as one of those that died had grown weak since receiving the first vaccine and was hardly a fit subject. It was in apparent good health when the experiment was started.

TABLE III

TABLE SHOWING RESULTS OF SHEEP EXPERIMENT

No.	Vaccination	Aug. 27 p.m.	Aug. 28 a.m.	Aug. 28 p.m.	Aug. 29 a.m.	Aug. 29 p.m.	Aug. 30 a.m.	Aug. 30 p.m.	Aug. 31 a.m.	Aug. 31 p.m.	Sept. 1 a.m.	Sept. 1 p.m.	Sept. 2 a.m.	Sept. 2 p.m.	Sept. 3 a.m.	Sept. 3 p.m.	Sept. 4 a.m.	Sept. 4 p.m.	Sept. 5 a.m.	Sept. 5 p.m.	Sept. 6 a.m	Sept. 6 p.m.	Sept. 7 a.m.	Remarks
		TEMPERATURES																						
1	Sero-Vaccine	103	103	104.7	106.6	106.6	106	106.6	106.2	107.1	107.4	106.8	106.4	107.2	106.7	107.1	105.5	106	104.6	104	102.9	104	103	
2	Sero-Vaccine	103.2	103	103.1	104.6	106.3	105.2	104	103.3	103	103.2	104	103	104	105.5	106.2	102.4	103	102.3	103.8	102	104	102.6	
3	Sero-Vaccine	102.8	103.3	104	105.6	106.2	105	106.1	106.6	105.7	Died night of Agust 31.													Anthrax in blood
4	Sero-Vaccine	103.6	103	105	106.4	105.2	103.4	103.6	103	107.9	103.2	103.5	102.1	103.2	102.1	103.1	102.3	103.4	102.4	103	101.2	103	101.7	
5	Sero-Vaccine	103	103.2	104.6	106.3	105.4	103.8	103.4	105.1	104.8	104.8	104.7	102.1	103.4	102.4	103.4	02.4	103.2	103.6	102.9	102.8	104.5	103	
6	Pasteur's V...	101.8	103.1	102.9	102.4	105.8	Died night of Aug. 29.																	Anthrax in blood
7	Pasteur's V...	103	103.2	103.3	105.5	107	107.4	107.3	105	105.9	104.7	105.1	106.6	107	106.3	106.4	107	107.2	107.3	106.6	Died night of Sept. 5			Anthrax in blood
8	Pasteur's V...	103	103.2	102.8	105.5	106.6	102.7	103.1	102.6	102.2	102	103.1	101.5	102.2	101.6	103.3	102.8	103.2	103.1	103.2	102	103.4	102.2	
9	Pasteur's V...	103	104.4	103	101.6	103.3	102.8	103.2	102	102.2	102	102.4	101.6	102.5	102.2	103.3	103.4	103.6	103.2	103.4	102.1	104	102.3	
10	Pasteur's V...	103.8	104	102.6	102.2	103.9	103.4	104.1	106.6	107	104.1	105.8	103.9	103.9	102.4	103	103	103.3	103	103.4	101.9	104	102.2	
11	Anthraxoid...	103.2	103.7	104	103.2	105	103.3	104.6	103	104.5	105.4	105	105.9	105.6	105.4	104.4	104.5	104	103.9	104.5	102.6	104.4	103.1	
12	Anthraxoid...	104	103.1	102.4	104.2	106.6	106.8	106	103	103.6	102.6	103.1	103.4	103.6	102.4	102.6	102.5	103	102.2	102.4	101.5	103.4	102.9	
13	Anthraxoid...	103	102	103.2	104.7	106.2	105.2	105.8	106.4	106.8	Died night of Aug. 31.													Anthrax in blood
14	Anthraxoid...	102.4	103.6	104.5	106.7	106.2	106.1	104.2	104.1	106.8	103.8	104.2	102.1	102.5	103	104.1	103.1	103.4	103	103.2	102	104.1	102.2	Lame Sept. 1–2
15	Anthraxoid...	103.6	103	104.2	106.7	106.4	103.6	103.1	102.7	103.6	106.4	105.3	102	102.9	105.4	103.2	102.6	105.3	102.2	102.7	102	103.2	102	
16	Control......	103	102.2	102.7	107	104.6	103.6	107.3	106.7	104.4	107.4	106.3	105	105	103.8	103.9	102.6	103.2	102.9	103.6	102.3	103.6	103	
17	Control......	103.5	102.8	103	102.7	106.3	107.4	107.1	105	104.4	103.4	105.5	105.5	106	104.4	103.7	105	104	103.8	104.1	102.6	104.4	101.9	
18	Control......	102.6	102.2	102.6	102	103	105.8	106.2	102.6	102.4	102.8	104	102	102.1	102.6	102.2	102.6	103.5	102.7	103	102	103.2	101.7	
19	Control.....	103.2	102.6	102.5	102.4	103	105.6	106.3	106.8	106.4	104.6	106.4	106.4	106.2	102.8	102.7	103.7	105.2	103.8	106.4	103.3	103.8	102.2	
20	Control.....	103.2	102.2	102.1	102.4	105	106.4	106.8	106.3	106.4	106.8	106.2	105.9		Died Sept. 3, a. m.									Anthrax in blood

Since the inoculating material was not strong enough to kill all the control sheep, it would appear that the different vaccines ought to have shown up particularly well in this experiment. As will be seen, however, that exactly similar results were obtained with the sheep receiving the different vaccines as with controls. Neither vaccine seemed superior to the others, nor were they of any advantage.

TABLE IV.

RESULTS OF BLOOD EXAMINATIONS OF TWO OF THE CONTROL SHEEP IN FORMER EXPERIMENTS.

No	Date	Temp.	No. Red Cells	No. White Cells	Leucorytes	Polynuclears	Eosenophiles	Mononuclears	Mast Cells
1	Aug. 29	102.4	6.448,000	5,200	40.1%	46.4%	3.4%	10.1%	1.0%
1	Aug. 30	105.6	8,336,000	8.000	30.0%	60.0%	2.0%	6.6%	1.3%
1	Aug. 31	106.8	7,888.000	9.450	22.4%	57.2%	1.5%	18.6%	0.3%
1	Sept. 2	106.4	7,884.000	8,600	31.9%	56.3%	1.0%	10.3%	5.0%
1	Sept. 3	102.8	9,200,000	11,200	46.2%	37.8%	2.5%	11.2%	0.7%
1	Sept. 5	103.8	7,728.000	7,000	50.0%	32.5%	3.7%	13.7%	0.1%
2	Aug. 29	107	7,755.000	11,500	38.0%	46.0%	1.0%	17.0%	1.0%
2	Aug. 30	107.3	8,338,000	12.000	39.3%	41.1%	5.3%	14.1%	0.2%
2	Aug. 31	104.4	6.104,000	10,200	34.7%	49.7%	0.7%	14.3%	0.5%
2	Sept. 2	105	7,820,000	10,000	39.7%	46.9%	2.5%	9.4%	1.5%
2	Sept. 3	103.4	8,600.000	10,100	57.6%	22.7%	4.9%	14.4%	0.4%
2	Sept. 6	102.6	9.200,000	8.500	45.4%	33.7%	5.4%	14.2%	1.3%

The next experiment was to determine the comparative virulence of Pasteur's vaccine No. 2 and Merck's vaccine. It is claimed by the manufacturers that Merck's culture is stronger than Pasteur's No. 2, and that by the use of the serum a more virulent culture can be used. But little can be found concerning the strength of this culture. Sobernheim, in one of his first articles, says it is a little stronger than Pasteur's No. 2.

In Table V is shown the comparative virulence of the two cultures upon small animals. Both vaccines were fresh, the animal adults in good health and of about equal size. Animals all inoculated August 14, '07, from a 24-hour agar culture.

TABLE V.

No.	Animal	Dose	Vaccine	Results	Remarks
1	Mouse	1-100 Loop	Pasteur's No. 2	Died 2 days	Few organisms in spleen
2	Mouse	1-100 Loop	Merck's	Died 2 days	Numerous " in spleen
3	G. Pig	1-100 Loop	Pasteur's No. 2	Died 4 days	Few organisms in spleen
4	G. Pig	1-100 Loop	Merck's	Died 2 days	Numerous " in spleen
5	Rabbit	1-100 Loop	Pasteur's No. 2	Survived	No symptoms of disease
6	Rabbit	1-100 Loop	Merck's	Died 3 days	Few organisms in spleen

From above table it will be seen that Merck's vaccine was really stronger than Pasteur's No. 2, in this case at least. It killed mice as soon as Pasteur's, but there were more bacteria in spleen. It killed a guinea pig two days sooner than Pasteur's No. 2, with more anthrax bacteria in the spleen, and killed a rabbit in three days, while Pasteur's failed to kill the latter.

In the next experiment the following vaccines were used, in order to get their virulence. Pasteur's anthrax vaccine in blue tubes, for sale by Pasteur Vaccine Company; Pasteur's anthrax vaccine, for sale by Sorby Vaccine Company, and Mulford's anthrax vaccine. It was our intention to use Merck's Sero-vaccine, but it could not be obtained at this time, so had to be omitted. The next table shows the results of the animal inoculations.

TABLE VI.

TABLE OF ANIMAL INOCULATIONS WITH DIFFERENT VACCINES.

No.	Date	Animal	Dose	Vaccine	Results	Remarks
				Pasteur's No. 1		
1	June 1	Mouse	0.5 cc	Amber vials	Died 2½ days	Organisms in spleen
2	June 1	Mouse	0.2 cc	Amber vials	Died 5 days	Organisms in spleen
3	June 1	G. Pig	1.0 cc	Amber vials	Survived	
				Pasteur's No. 1		
4	June 1	Mouse	0.5 cc	Blue vials	Died 2 days	Organisms in spleen
5	June 1	Mouse	0.2 cc	Blue vials	Died 3 days	Organisms in spleen
6	June 1	G. Pig	0.5 cc	Blue vials	Died 6 days	Organisms in spleen
7	June 9	Mouse	0.5 cc	Mulford's No. 1	Survived	
8	June 9	Mouse	0.2 cc	Mulford's No. 1	Survived	
9	June 9	G. Pig	1.0 cc	Mulford's No. 1	Survived	
				Pasteur's No. 2		
10	June 1	G. Pig	0.5 cc	Amber vials	Died 3 days	Organisms in spleen
11	June 1	Rabbit	0.5 cc	Amber vials	Survived	
				Pasteur's No. 2		
12	June 1	G. Pig	0.5 cc	Blue vials	Survived	
13	June 1	Rabbit	0.5 cc	Blue vials	Survived	
14	June 9	G. Pig	1.0 cc	Mulford's No. 2	Survived	
15	June 9	Rabbit	1.0 cc	Mulford's No. 2	Survived	

A glance at the above table will show that Pasteur's vaccine in amber vials (Sorby Vaccine Co.) was of about the right virulence. Pasteur's Vaccine Co. vaccine (in blue vials) showed more irregularity, in that No. 1 appeared stronger than No. 2. Mulford's vaccine was evidently weaker than the others.

Agar plate-cultures from the different vaccines gave numerous colonies slightly resembling anthrax. Stained preparations showed them to be anthrax. After several generations on agar, the growth became more characteristic.

All cultures went on to form spores, except those from No. 2, Pasteur Vaccine Co.; Sorby Vaccine Co., No. 1; and Mulford's No. 1.

IMMUNITY EXPERIMENTS.

Several experiments were undertaken with the idea of securing a high degree of immunity in sheep along with the production of an antitoxic serum. Sobernheim, from a series of experiments, concluded that serum from animals of a high degree of immunity possessed marked antitoxic properties, valuable both as a preventive and curative agent.

The first attempt the writer made to secure immunity was upon four sheep. Two were vaccinated with Pasteur's vaccine and two with an anthraxoid. This was the same experiment as recorded in Experiment No. 4. It will be noticed that all the animals died before receiving a large dose of the organisms, so their serum was not tested.

The next experiment showed up somewhat better, but was given up after the animals had received 1/50 loop of agar culture. This was the same experiment as described under No. IV.

The final sheep were those that had survived the infection of 1/2 loop of agar culture in the experiment in which 20 sheep were used. The inoculations were repeated at intervals of about two weeks, with increased doses. The inoculated material was from 24-hour agar cultures washed off and suspended in sterile water. The inoculations were made on the inside of the thigh in each case. No more serious symptoms developed than a slight swelling at the point of inoculation and a slight elevation of temperature.

The following table shows the time of the inoculations and the doses used:

Table VII.

These animals, two in number, had been vaccinated; also had received one-half of virulent culture previous to this experiment.

Date	Dose	Remarks
Nov. 9	3 Loops.	
Nov. 23	6 Loops.	
Dec. 7	1 Agar culture	
Dec. 21	1 Agar culture	Passed through a mouse
Jan. 4	1½ Agar culture	
Jan 21	3 Agar culture	
Feb. 3	4 Agar culture	Passed through a guinea pig. Pig died in 36 hours
Feb. 20	5 Agar culture	
March 5	6 Agar culture	
March 19	7 Agar culture	
April 6	8½ Agar culture	From pig
April 21	10½ Agar culture	
May 4	12 Agar culture	
May 18	15 Agar culture	
June 1	17 Agar culture	Passed through a guinea pig. Killed in 36 hours
June 15	20 Agar culture	
July 1	25 Agar culture	
July 15	30 Agar culture	
July 29	35 Agar culture	

The serum was not tested until after 3 agar cultures had been given, then after 17 and 25 cultures. The blood was always drawn from the jugular 14 days after the inoculation. Serum was injected 24 hours previous to the inoculation.

The next table shows the results obtained after receiving three agar cultures.

Table VIII.

No.	Date	Animal	Weight	Antitoxin	Dose of Culture	Results	Remarks
1	Jan. 22, '08	Rabbit	1580 grms	2½ cc. Sheep No. 1	1-25 loop*	Died Jan. 27	Anthrax bacteria in spleen
2	Jan. 22, '08	Rabbit	1500 grms.	2½ cc. Sheep No. 2	1-25 loop	Survived	Anthrax bacteria in spleen
3	Jan. 22, '08	Rabbit	1600 grms	Control	1-25 loop	Died Jan. 28	Anthrax bacteria in spleen
4	Jan. 22, '08	G. Pig	400 grms.	2½ cc. No. 1	1-25 loop	Died Jan. 25	Anthrax bacteria in spleen
5	Jan. 22, '08	G. Pig	370 grms.	1½ cc. No. 2	1-25 loop	Died Jan. 25	Anthrax bacteria in spleen
6	Jan. 22, '08	G. Pig	385 grms.	Control	1-25 loop	Died Jan. 24	Anthrax bacteria in spleen

*Loop always means, 1 loop of growth on agar 24 hour culture.

It will be noticed that of the rabbits No. 2 survived, while No. 1 died before the control. One guinea pig died before and one after the control. It appears that no apparent immunity was secured from the use of the serum at this time. No doubt No. 1 survived more on account of its natural immunity than from the effects of the serum.

The following experiment was carried on exactly as the preceding, except that only rabbits were used and the blood drawn 14 days after receiving 17 tubes of the organism.

TABLE IX.

No.	Date June	Weight	Antitoxin	Dose of Culture	Results
1	~~Jan.~~ 18	1400 grms	1½ cc. No. 1	1-25 loop	Survived
2	~~Jan.~~ 18	1480 grms.	5 cc. No. 1	1-25 loop	Survived
3	~~Jan.~~ 18	1350 grms.	2½ cc. No. 2	1-25 loop	Survived
4	~~Jan.~~ 18	1500 grms.	5 cc. No. 2	1-25 loop	Survived
5	~~Jan.~~ 18	1378 grms.	Control	1-25 loop	Survived

Evidently the inoculating material was not strong enough, as all survived. They were reinoculated again July 3 with a more virulent culture, with the following results.

No. 1 died the night of July 3.
No. 2 survived.
No. 3 died night of July 3.
No. 4 died July 4.
No. 5 survived.

Here again irregularity is seen, as all except the control and No. 2 died. No appreciable antitoxic property is yet in evidence.

In the following table results are shown. The sheep had received 25 tubes of the organisms. A very virulent culture was used in this experiment.

TABLE X.

No.	Date	Antitoxin	Dose of Culture	Results	Remarks
1	July 15	2½ cc. Sheep No. 1	1-25 loop	Died July 23	Anthrax bacteria in peripheral blood
2	July 15	5 cc. Sheep No. 1	1-25 loop	Died July 21	Anthrax bacteria in peripheral blood
3	July 15	8 cc. Sheep No.1	1-25 loop	Died July 21	Anthrax bacteria in peripheral blood
4	July 15	2½ cc. Sheep No. 2	1-25 loop	Survived	
5	July 15	5 cc. Sheep No. 2	1-25 loop	Died July 21	Anthrax bacteria in peripheral blood
6	July 15	Control	1-25 loop	Died July 17	Anthrax bacteria in peripheral blood

The rabbits used in this experiment were all of about the same weight. As will be seen from the table the control died in about two days, while No. 4 survived and the others survived for at least four days longer than the control. It would seem that in this experiment at least there was some degree of immunity acquired from receiving the serum.

The following summary of the most important facts regarding anthrax, or charbon, is reprinted from Bulletin No. 60 of the Louisiana Station:

Charbon is caused by a specific micro-organism, the *Bacterium anthracis,* found in large numbers in the *blood* of all animals dying from the disease.

The germ belongs to the spore-bearing variety, which renders it more difficult to control, owing to the spores being very resistant to destructive influences, and that it is capable of vegetating outside of the animal body.

All varieties of domestic, as well as our common wild animals, are susceptible to the disease, either by infection through the alimentary tract, or externally by the skin.

The human subject can easily become inoculated through abrasions of the skin by handling, and particularly skinning charbonous carcasses.

Certain sections of the State have been infected with charbon for a time antedating the recollection of the oldest inhabitants.

The infection has been augmented, from time to time, by neglect of carefully destroying the germ-laden carcasses.

The disease usually succeeds showers subsequent to protracted spells of drought.

Gad or horse-flies (*Tabanidae*) carry the contagion from charbonous carcasses, or, in some instances, from living animals suffering from charbon, and inoculate healthy stock.

Horse-flies are generally numerous about the time that charbon occurs, and hence favor the wider spread of the disease.

The spores of charbon can be conveyed through the medium of food-materials raised on infected lands.

Animals grazing over infected pastures can contract the disease.

The disease can be introduced from foreign countries through importation of hides or wool of animals that have died from charbon.

Charbon may be introduced in fertilizers containing the tissues of charbonous carcasses, if not subjected to sufficiently high temperature to destroy the spores.

The contagion may be disseminated by running water, by carnivorous and omnivorous animals, by buzzards and carrion crows, by the feet of man, etc.

The number of the various horseflies may be reduced by the application of kerosene to pools and humid spots in woods, etc., which these insects frequent.

Preventive inoculation, when carried out with good vaccine, under careful antiseptic precautions, has, if not entirely prevented the disease, lessened the number of fatalities.

Total eradication of charbon contagion, from sections long infected, is improbable in the near future.

The disease cannot be successfully combated by curative agents, but only by *strict sanitary measures.*

The best known means for preventing the spread of charbon are:

(1) The proper disposition of the bodies of all animals that die of the disease, by burning or deeply burying, previously keeping the skin whole, and preventing blood or other discharges from the natural openings, as the nostrils, mouth, rectum, etc. This will destroy the contagion in the carcasses, and deprive the different transmitting agencies of the source from which the disease can be spread.

(2) The thorough destruction by burning, or powerful disinfection, manure, litter, and everything else that has been in contact with the diseased or dead animal.

(3) Preventing the overflow of lands used for pasture or for growing hay or other forage crops. Or, by the draining of lands used for pasture, or for the production of hay or other food crops, in case there is stagnant water, or in case the land has an impervious subsoil.

(4) Preventive inoculation with reliable material early in the season; using, during the operation, strict antiseptic care; and carefully following instructions with regard to the use of the vaccine or lymph, and the care of the animal until immunity is established.

(5) Uniformity of effort in the carrying out of strict sanitary measures, which, to accomplish the best results, should be enforced by State law.

The skinning of charbonous carcasses is very much to be deprecated, and should be strictly prohibited by law, as such a practice is not only dangerous to the operator, but the hides are a fruitful means of spreading anthrax through the infected blood they contain, and which the tanning process does not render innocuous. Almost every year there are records of deaths among employees of tanneries throughout the country resulting from inoculation while handling such hides.

Relative to preventive vaccine, it is of the utmost importance that it should be fresh and reliable, and that all those handling it, whether dealers in it, or stock owners, should follow carefully the instructions (which generally accompany the material) necessary for its preservation and reliability. If this is not done, the vaccine will deteriorate; may become infected, and, in fact, be rendered useless or even dangerous.

Note.—The Experiment Station at Baton Rouge is prepared to make microscopic examinations of blood for anthrax. It should be understood that animal tissues, including blood, are very susceptible to putrefactive changes during hot weather, which renders them useless for microscopic examination. Hence the sooner they are examined after death the better is the chance for an accurate diagnosis.

There are two very good methods by which the blood may be taken and sent to the station: (1) Immediately after death of the animal, if possible, cut off half of an ear and place the specimen in a wide-mouthed bottle, such as a quinine bottle, that has previously been boiled to spoil any infection. The bottle should then be tightly sealed, carefully packed and mailed, or sent by express, prepaid. (2) On a small, thin piece of clean glass, three by one inches, place one drop of blood from a newly-dead animal. Then with another similar piece of glass spread the drop of blood out into a thin film over the first piece. The film of blood should then be slowly dried in the sun, and the piece of glass, with the film of blood on it, carefully packed in a small suitable box for mailing. This is perhaps the better method of the two in this climate, as the blood will keep better, and the film can be stained and examined without having to transfer it to the regular microscope slide.

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OF THE

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and A. & M. College,

BATON ROUGE.

COMPARISON
OF
COTTON SEED MEAL AND HULLS
WITH
COLD PRESSED CAKE
AS A DAIRY FEED

BY

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Comparison of Cotton Seed Meal and Hulls, with Cold Pressed Cake as a Dairy Feed.

BY J. G. LEE, B. S., EXP. STATION OF LA. STATE UNIVERSITY.
T. E. WOODWARD, B.S., DAIRY DIVISION, BUREAU OF ANIMAL INDUSTRY,
U. S. DEPT. OF AGRICULTURE.

During the winter and spring of the present year (1908), an experiment was conducted by J. G. Lee, Jr., of the experiment station of the Louisiana State University, and T. E. Woodward, of the Bureau of Animal Industry of the U. S. Department of Agriculture, at the dairy barn of Mr. W. W. Nott, Hammond, La., for the purpose of determining (if possible) the true value of cold pressed cotton seed cake* as a feed for dairy cows. As cotton seed meal is one of the chief feeds for dairy cows in this state, and the chief source upon which the dairymen depend for obtaining their protein, it was thought best to compare the

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*Cold pressed cake is the residue of cotton seed from which the oil has been extracted by compression, without separating the kernels and the hulls and without heating.

Following are the analyses of the feeds used in these experiments, as determined in the Chemical Laboratory of the Experiment Station at Baton Rouge:

	Percentage of Moisture.	Percentage of Protein.	Percentage of Fat.
Cold pressed cake	8.34	28.19	6.16
Cold pressed cake	10.06	25.56	7.35
Cotton seed meal	6.52	44.56	8.31
Corn meal	10.17	9.63	3.69
Cotton-seed hulls	10.92	3.69	.62
Alfalfa hay	11.48	14.00	1.83

The cows fed the cotton seed meal and hull ration received slightly more protein and a little less fat than those fed cold pressed cake, as shown in the following figures:

	Pct. of Protein.	Pct. of Fat.	—One Part— Protein.	Fat.
One part cold pressed cake contains...	28.19	6.16	28.19	6.16
Two parts cotton-seed meal contain..	89.12	16.62		
One part hulls contains...............	3.69	.62		
	92.81	17.24÷3=	30.93	5.74

cold pressed cake with this meal. Accordingly, the cold pressed cake was fed in comparison to a mixture of meal and hulls—two parts by weight of meal to one part by weight of hulls—previous analysis having shown cold pressed cake to be fully one-third hulls.

Twelve cows giving a good flow of milk were selected for the experiment and were divided into two lots of six each. Lot No. 1 was fed the following ration for the first twenty-eight days of the experiment, a week being allowed for the animals to become accustomed to the feed:

Alfalfa hay, one part; Hulls, two parts.—(Designated hereafter as Ration No. 1a.)

Cotton seed meal, two parts; Hulls, one part; Corn meal, three parts.—(Designated hereafter as Ration No. 2a.)

Ration 1a was fed for maintenance, at the rate of two pounds of the mixture for each one hundred pounds live-weight; example, an animal weighing seven hundred fifty pounds would receive five pounds of alfalfa hay and ten pounds of hulls per day; one weighing nine hundred pounds would receive six pounds of alfalfa hay and twelve pounds of hulls per day, etc.

Ration 2a was fed for milk production, one pound of the mixture being fed to every two pounds of milk produced; example, a cow giving twenty pounds of milk per day received ten pounds of the 2a mixture. This is really more concentrates than is generally thought advisable to feed; but, considering the class of roughage that was available and the small amount of alfalfa hay fed, the concentrates were probably not fed in excess; while. if a larger amount of alfalfa hay had been fed, the concentrates would have been reduced considerably.

Lot No. 2 was fed the first twenty-eight days the same ration as Lot No. 1, except that cold pressed cake was substituted, pound for pound, in 2a for cotton seed meal and hulls.

At the end of the first twenty-eight days Lot No. 1 was placed on cold pressed cake and Lot 2 on cotton seed meal and hulls. In this way any errors that might have arisen by differences in the individual cows of the two lots, the advance in lactation period, etc., were eliminated.

The amount of grain to be fed was governed entirely by the milk production. If a cow averaged twenty pounds of milk for any one week, she was fed the following week according to her average for the previous week, which would take, in this case, where twenty was the average, ten pounds of grain.

In order to determine the amount of roughage to be fed, each cow was weighed at beginning of experiment and, also, when the change was made at the end of the first twenty-eight days; then put on the maintenance ration, 1a, two pounds roughage per day for each one hundred pounds live weight. They were kept on this ration until it was found that the roughage would have to be reduced on account of the appearance of grass on spring pastures; therefore, the roughage was gradually reduced until, at the end of the experiment, each cow was receiving one pound of 1a to every one hundred pounds live-weight.

The cows were fed twice daily, half the ration being fed in the morning and half in the evening. Every pound of feed consumed was weighed out to each cow, and every pound of milk produced was weighed, also, samples of milk from each cow were taken twice daily and the composite sample tested at the end of every week.

We have, then, accurate data as to the amount of feed consumed, amount of milk produced and amount of butterfat produced by each individual cow.

Complete records were kept of the variation in daily and weekly average of milk production and in per cent. fat of each individual cow embracing both periods of the experiment. The figures in the first table are presented just as they were taken at the barn, and as an illustration of the method of securing the data from each cow, the total results of which are summarized in the succeeding tables.

TABLE I.

LOT I, FIRST PERIOD.

Cow named "Jennie." Breed: Grade Jersey. Freshened Oct. 15, 1907. Weight 730 pounds.

Date	For Maintenance		For Milk Production			Daily Milk Production		Total Milk Production per day	Test Week	Average Milk Production per day
	Alfalfa	Hulls	C. S. Meal	Hulls	C. Meal	A. M.	P. M.		Fat %	
Feb. 28....	4.8	9.7	2.0	1.0	3.0	6.2	5.9	12.1	5.2	11.6
" 29....	4.8	9.7	2.0	1.0	3.0	7.0	6.1	13.1		
March 1....	4.8	9.7	2.0	1.0	3.0	6.9	5.8	12.7		
" 2....	4.8	9.7	2.0	1.0	3.0	7.1	5.4	12.5		
" 3....	4.8	9.7	2.0	1.0	3.0	7.2	5.8	13.0		
" 4....	4.8	9.7	2.0	1.0	3.0	6.7	6.0	12.7		
" 5....	4.8	9.7	2.0	1.0	3.0	6.8	6.0	12.8	4.6	12.7
" 6....	4.8	9.7	2.0	1.0	3.0	7.0	6.0	...		
" 7....	4.8	9.7	2.0	1.0	3.0	7.7	5.9	...		
" 8....	4.8	9.7	2.0	1.0	3.0	7.4	6.4	...		
" 9....	4.8	9.7	2.0	1.0	3.0	7.1	6.1	...		
" 10....	4.8	9.7	2.0	1.0	3.0	7.3	5.4	...		
" 11....	4.8	9.7	2.0	1.0	3.0	7.0	6.0	...		
" 12....	4.8	9.7	2.0	1.0	3.0	7.4	5.9	...	4.7	13.2
" 13....	4.8	9.7	2.2	1.0	3.3	7.1	5.6	...		
" 14....	4.8	9.7	2.2	1.0	3.3	6.5	5.6	...		
" 15....	4.8	9.7	2.2	1.0	3.3	6.7	5.6	...		
" 16....	4.8	9.7	2.2	1.0	3.3	6.5	5.9	...		
" 17....	4.8	9.7	2.2	1.0	3.3	7.6	5.6	...		
" 18....	4.3	8.7	2.2	1.0	3.3	7.1	5.8	...		
" 19....	4.3	8.7	2.2	1.0	3.3	7.4	6.2	...	4.8	12.6
" 20....	3.8	7.7	2.1	1.0	3.1	7.0	6.1	...		
" 21....	3.8	7.7	2.1	1.0	3.1	6.8	5.9	...		
" 22....	3.8	7.7	2.1	1.0	3.1	7.0	5.9	...		
" 23....	3.8	7.7	2.1	1.0	3.1	7.1	5.6	...		
" 24....	3.8	7.7	2.1	1.0	3.1	6.9	5.7	...		
" 25...	3.8	7.7	2.1	1.0	3.1	7.0	5.9	...		
" 26....	3.8	7.7	2.1	1.0	3.1	7.1	5.6	...	4.5	12.8

LOT I, SECOND PERIOD.

Cold pressed cake substituted for cotton seed meal and hulls.

Weight, 750 pounds.

Date	For Maintenance		For Milk Production—Cold Pressed Cake	C. Meal	Daily Milk Production			Test Week	Average Milk Production per day
	Alfalfa	Hulls			A. M.	P. M.		Fat %	
March 27	4.3	8.7	3.2	3.2	6.8	5.7	...		
" 28	4.0	8.0	3.2	3.2	7.4	5.7	...		
" 29	4.0	8.0	3.2	3.2	7.1	6.0	...		
" 30	4.0	8.0	3.2	3.2	6.6	6.0	...		
" 31	4.0	8.0	3.2	3.2	6.8	5.7	...		
April 1	4.0	8.0	3.2	3.2	7.0	6.2	...		
" 2	4.0	8.0	3.2	3.2	6.9	6.1	...		
" 3	4.0	8.0	3.2	3.2	7.0	5.4	...		
" 4	4.0	8.0	3.2	3.2	6.9	6.0	...		
" 5	3.6	7.0	3.2	3.2	7.1	6.0	...		
" 6	3.5	7.0	3.2	3.2	6.4	5.7	...		
" 7	3.5	7.0	3.2	3.2	6.6	5.7	...		
" 8	3.5	7.0	3.2	3.2	7.0	5.9	...		
" 9	3.5	7.0	3.2	3.2	7.0	5.8	...	4.5	12.6
" 10	3.5	7.0	3.3	3.3	7.4	5.7	...		
" 11	3.5	7.0	3.3	3.3	7.1	5.9	...		
" 12	3.5	7.0	3.3	3.3	6.8	5.5	...		
" 13	3.5	5.5	3.3	3.3	7.2	5.9	...		
" 14	3.5	7.0	3.3	3.3	7.0	5.7	...		
" 15	3.0	6.0	3.3	3.3	6.8	6.0	...		
" 16	2.5	5.0	3.3	3.3	7.2	5.6	...	4.4	12.8
" 17	2.5	5.0	3.2	3.2	6.8	5.4	...		
" 18	2.5	5.0	3.2	3.2	7.1	5.7	...		
" 19	2.5	5.0	3.2	3.2	6.9	5.5	...		
" 20	2.5	5.0	3.2	3.2	7.0	5.9	...		
" 21	2.5	5.0	3.2	3.2	6.7	5.9	...		
" 22	2.5	5.0	3.2	3.2	7.3	5.5	...		
" 23	2.5	5.0	3.2	3.2	6.8	5.7	...	4.4	12.6

In the following tables will be found the individual records of each cow for both periods as regards the milk production, butter-fat test and pounds of butter-fat for every week embracing both periods of the experiment:

TABLE II.

Lot 1, First Period.

"JENNIE."

	Lbs. Milk.	Average Pct. Fat.	Total Butter Fat, Lbs.	Average Feed Consumed Daily: Ration 1a.	Ration 2a.
1st week....	88.9	4.6	4.09	14.5	6.0
2d "	92.6	4.7	4.35	14.5	6.0
3d "	89.2	4.8	4.28	14.5	6.5
4th "	89.6	4.5	4.03	11.5	6.2
Total.....	360.3	4.65	16.75		

This cow received cotton-seed meal aud hulls during the first period.

Second Period.

	Lbs. Milk.	Average Pct. Fat.	Total Butter Fat, Lbs.	Average Feed Consumed Daily: Ration 1a.	Ration 2a.
5th week....	90.0	4.4	3.96	12.0	6.4
6th "	88.5	4.5	3.98	10.9	6.4
7th "	89.8	4.4	3.95	9.6	6.6
8th "	88.2	4.4	3.88	7.5	6.4
Total.....	356.5	4.42	15.77		

During this period cold pressed cake was substituted for cotton-seed meal and hulls.

In the above record, a difference of 3.8 lbs. is found in the milk production in favor of the cotton-seed meal and hulls, and a difference of .99 lbs. butterfat in favor of cotton-seed meal and hulls. When we take into consideration that the lactation period was further advanced during the second period, there is really no difference in the total production during the two periods.

TABLE III.

Lot 1, Cont'd, 1st Period.

"ANNIE."

				Average Feed Consumed Daily:	
	Lbs. Milk.	Average Pct. Fat.	Total Butter Fat, Lbs.	Ration 1a.	Ration 2a.
1st week....	123.4	4.2	5.18	16.8	8.0
2d "	130.4	4.4	5.74	16.8	9.0
3d "	133.9	4.1	5.49	16.4	9.0
4th "	131.6	3.9	5.13	13.8	9.4
Total.....	519.3	4.15	21.54		

Cotton-seed meal and hulls was fed during this period.

Second Period.

				Average Feed Consumed Daily:	
	Lbs. Milk.	Average Pct. Fat.	Total Butter Fat, Lbs.	Ration 1a.	Ration 2a.
5th week....	130.5	4.0	5.22	13.4	9.4
6th "	126.0	3.9	4.91	12.1	9.4
7th "	125.1	3.8	4.75	11.2	9.0
8th "	118.2	4.1	4.85	8.1	9.0
Total.....	499.8	3.95	19.73		

Cold pressed cake was fed during this period.

The records of this cow show a difference of 19.5 lbs. of milk in favor of the cotton-seed meal and hulls and, also, a slight difference in favor of the C. S. M. and hulls in production of butterfat. A difference is also noticed in the average per cent of fat: during the first period, the weekly tests averaged 4.15%, while during the second period, where the total milk production is lower than in the first, the average per cent of fat is also lower.

TABLE IV.

Lot 1, Cont'd, 1st Period.

"LIZER."

				Average Feed Consumed Daily:	
	Lbs. Milk.	Average Pct. Fat.	Total Butter Fat, Lbs.	Ration 1a.	Ration 2a.
1st week....	154.0	4.2	6.47	15.0	10.0
2d "	161.2	3.9	6.29	15.0	10.8
3d "	159.6	3.7	5.90	14.5	11.4
4th "	152.4	3.9	5.94	12.3	11.4
Total.....	627.2	3.92	24.60		

Cotton-seed meal and hulls fed during this period.

Second Period.

	Lbs. Milk.	Average Pct. Fat.	Total Butter Fat, Lbs.	Average Feed Consumed Daily: Ration 1a.	Ration 2a.
5th week....	147.9	4.0	5.91	12.5	11.0
6th "	141.9	4.0	5.68	11.2	11.0
7th "	138.9	3.8	5.28	10.3	10.0
8th "	134.1	4.3	5.77	7.8	10.0
Total.....	562.8	4.02	22.64		

Cold Pressed cake fed during this period.

During the first period the above cow gave a total of 627.2 lbs. milk, while receiving the cotton-seed meal and hulls, but gave only a total of 562.8 lbs. on cold pressed cake, or a difference of 64.4 lbs. in favor of the cottton-seed meal and hulls. The total butterfat also shows a difference in favor of the cotton-seed meal and hulls.

TABLE V.

Lot 1, Cont'd, 1st Period.

"SCRAPPIE."

	Lbs. Milk.	Average Pct. Fat.	Total Butter Fat, Lbs.	Average Feed Consumed Daily: Ration 1a.	Ration 2a.
1st week....	131.7	4.6	6.06	13.5	7.5
2d "	136.0	4.4	5.98	13.5	9.0
3d "	151.9	4.0	6.08	13.0	9.4
4th "	151.1	4.2	6.35	10.5	10.6
Total.....	570.7	4.29	24.47		

Received cotton-seed meal and hulls during this period.

Second Period.

	Lbs. Milk.	Average Pct. Fat.	Total Butter Fat, Lbs.	Average Feed Consumed Daily: Ration 1a.	Ration 2a.
5th week....	152.8	4.2	6.42	10.0	10 8
6th "	158.1	4.0	6.32	9.1	10.8
7th "	152.2	4.3	6.54	7.5	11.2
8th "	144.5	4.4	6.36	6.3	10.8
Total.....	607.6	4.22	25.64		

Received cold pressed cake during this period.

The records of this cow show a difference of 36.9 lbs. in milk production and 1.17 lbs. in butterfat production in favor of the cold pressed cake; the per cent of fat remaining about the same throughout the experiment.

TABLE VI.

Lot 1, Cont'd, 1st Period.

"MARY."

	Lbs. Milk.	Average Pct. Fat.	Total Butter Fat, Lbs.	Average Feed Consumed Daily: Ration 1a.	Ration 2a.
1st week....	214.2	3.7	7.93	18.0	14.5
2d "	231.5	3.2	7.41	18.0	15.0
3d "	233.0	3.2	7.46	17.5	16.4
4th "	223.1	3.1	6.92	15.0	16.6
Total.....	901.8	3.30	29.72		

Received cotton-seed meal and hulls.

Second Period.

	Lbs. Milk.	Average Pct. Fat.	Total Butter Fat, Lbs.	Average Feed Consumed Daily: Ration 1a.	Ration 2a.
5th week....	216.2	3.5	7.57	15.0	15.9
6th "	212.7	3.6	7.66	14.8	15.4
7th "	199.5	3.3	6.58	12.6	15.2
8th "	174.5	3.3	5.76	9.0	14.2
Total.....	802.9	3.43	27.57		

Received cold pressed cake.

As seen from the above record, the cotton-seed meal and hull ration produced 98.9 lbs. more milk and 2.15 lbs. more butterfat than did the cold pressed cake ration, while the per cent fat remained about the same in each case.

TABLE VII.

Lot 1, Cont'd, 1st Period.

"CRICKET."

	Lbs. Milk.	Average Pct. Fat.	Total Butter Fat, Lbs.	Average Feed Consumed Daily: Ration 1a.	Ration 2a.
1st week....	125.2	4.5	5.63	14.2	9.0
2d "	140.3	4.3	6.03	14.2	9.0
3d "	143.1	4.2	6.01	13.8	9.9
4th "	147.1	4.2	6.18	11.2	10.2
Total.....	555.7	4.29	23.85		

Received cotton-seed meal and hulls.

Second Period.

	Lbs. Milk.	Average Pct. Fat.	Total Butter Fat, Lbs.	Average Feed Consumed Daily:	
				Ration 1a.	Ration 2a.
5th week....	140.1	4.2	5.88	11.4	10.4
6th “	135.4	4.4	5.96	10.0	10.0
7th “	131.4	4.0	5.26	9.0	9.6
8th “	122.0	4.2	5.12	7.2	9 4
Total.....	528.9	4.20	22.22		

Received cold pressed cake.

The above record shows a difference of 26.8 lbs. milk and 1.63 lbs. butterfat in favor of the cotton-seed meal and hull ration. The per cent of fat in this case, like most previous records, remained about the same.

TABLE VIII.

Lot 2, 1st Period.

“ANNA BELL.”

	Lbs. Milk.	Average Pct. Fat.	Total Butter Fat, Lbs.	Average Feed Consumed Daily:	
				Ration 1a.	Ration 2a.
1st week....	139.2	4.3	5.99	14.4	9.4
2d “	148.2	4.1	6.08	14.4	9.8
3d “	142.9	4.1	5.86	13.9	10.5
4th “	145.1	4.2	6.09	11.4	10.0
Total.....	575.4	4.17	24.02		

Received cold pressed cake.

Second Period.

	Lbs. Milk.	Average Pct. Fat.	Total Butter Fat, Lbs.	Average Feed Consumed Daily:	
				Ration 1a.	Ration 2a.
5th week....	143.7	4.1	5.89	11.9	10 0
6th “	143.3	4.2	6.02	10.3	10.0
7th “	140.0	4.2	5.88	8.9	10.2
8th “	146.1	4.2	6.14	7.5	10.0
Total.....	573.1	4.18	23.93		

Received cotton-seed meal and hulls.

In the above record, the total milk production shows a difference of 2.3 lbs. in favor of the cold pressed cake; the per cent fat and total butterfat being about the same in each period.

TABLE IX.

Lot 2, 1st Period, Cont'd.

"ALICE."

	Lbs. Milk.	Average Pct. Fat.	Total Butter Fat, Lbs.	Average Feed Consumed Daily: Ration 1a.	Ration 2a.
1st week....	150.4	4.6	6.92	16.3	10.0
2d "	158.8	4.4	6.99	16.3	10.6
3d "	162.3	4.2	6.82	15.8	11.0
4th "	163.0	4.3	7.01	13.3	11.4
Total.....	634.5	4.37	27.74		

Received cold pressed cake.

Second Period.

	Lbs. Milk.	Average Pct. Fat.	Total Butter Fat, Lbs.	Average Feed Consumed Daily: Ration 1a.	Ration 2a.
5th week....	164.0	4.0	6.56	13.4	11.4
6th "	158.9	4.0	6.36	12.0	11.4
7th "	157.8	3.9	6.15	11.0	11.2
8th "	154.5	4.0	6.18	8.1	11.2
Total.....	635.1	3.98	25.25		

Received cotton-seed meal and hulls.

In this case the total milk production, for both periods, is about equal; the cold pressed cake produced slightly more butterfat; per cent fat was slightly higher in the first period than in the second.

TABLE X.

Lot 2, Cont'd, 1st Period.

"BOB."

	Lbs. Milk.	Average Pct. Fat.	Total Butter Fat, Lbs.	Average Feed Consumed Daily: Ration 1a.	Ration 2a.
1st week....	123.1	4.5	5.54	13.2	8.5
2d "	138.5	4.4	6.09	13.2	8.8
3d "	144.8	4.3	6.23	12.8	9.5
4th "	148.1	4.3	6.37	10.2	10.2
Total.....	554.5	4.37	24.23		

Received cold pressed cake.

Second Period.

	Lbs. Milk.	Average Pct. Fat.	Total Butter Fat, Lbs.	Average Feed Consumed Daily: Ration 1a.	Ration 2a.
5th week....	151.7	4.0	6.07	11.2	10.6
6th "	144.8	4.2	6.08	9.9	10.8
7th "	146.2	3.9	5.70	8.9	10.2
8th "	143.3	4.0	5.73	7.2	10.4
Total.....	586.0	4.02	23.58		

Received cotton-seed meal and hulls.

In this case the cotton-seed meal and hull ration produced 31.5 lbs. more milk than the cold pressed ration. The butterfat shows an increase in favor of the cold pressed ration.

TABLE XI.

Lot 2, 1st Period, Cont'd.

"BLACKIE."

	Lbs. Milk.	Average Pct. Fat.	Total Butter Fat, Lbs.	Average Feed Consumed Daily: Ration 1a.	Ration 2a.
1st week....	179.9	3.5	6.30	16.8	11.8
2d "	196.6	3.3	6.49	16.8	12.8
3d "	209.2	3.4	7.11	16.3	14.0
4th "	221.9	3.3	7.32	13.8	14 8
Total.....	807.6	3.37	27.22		

Received cold pressed cake.

Second Period.

	Lbs. Milk.	Average Pct. Fat.	Total Butter Fat, Lbs.	Average Feed Consumed Daily: Ration 1a.	Ration 2a.
5th week....	228.5	3.2	7.31	15.9	15.6
6th "	234.1	3.3	7.73	14.5	16.2
7th "	231.2	3.2	7.40	13.5	16.6
8th "	229.9	3.2	7.36	9.3	16.6
Total.....	923.7	3.23	29.80		

Received cotton-seed meal and hulls.

This cow's record shows a big difference in favor of cotton-seed meal and hulls. The cotton-seed meal ration produced 116.1 lbs. more milk than the cold pressed cake ration, and, also, produced slightly more butterfat, the weekly tests being about the same in each case.

TABLE XII.

Lot 2, Cont'd, 1st Period.

"NELLIE."

				Average Feed Consumed Daily:	
	Lbs. Milk.	Average Pct. Fat.	Total Butter Fat, Lbs.	Ration 1a.	Ration 2a.
1st week....	153.0	4.1	6.27	17.5	10.6
2d "	165.2	4.0	6.61	17.5	10.8
3d "	174.0	3.8	6.61	17.0	11.5
4th "	175.8	4.0	7.03	14.5	12.4
Total.....	668.0	3.97	26.52		

Received cold pressed cake.

Second Period.

				Average Feed Consumed Daily:	
	Lbs. Milk	Average Pct. Fat.	Total Butter Fat, Lbs.	Ration 1a.	Ration 2a.
5th week....	184.2	3.7	6.82	14.6	12.6
6th "	177.2	3.8	6.73	13.2	13.0
7th "	169.8	3.7	6.28	12.2	12.6
8th "	164.3	3.8	6.24	8.7	12.2
Total.....	695.5	3.75	26.07		

Received cotton-seed meal and hulls.

In the above record, the cotton-seed meal and hull ration produced 27.5 lbs. more milk than the cold pressed cake ration: the per cent fat and total butterfat being about the same in each case.

TABLE XIII.

Lot 2, Cont'd, 1st Period.

"ANNIE LAURIE."

				Average Feed Consumed Daily:	
	Lbs. Milk.	Average Pct. Fat.	Total Butter Fat, Lbs.	Ration 1a.	Ration 2a.
1st week....	123.5	5.4	6.67	13.4	9.0
2d "	131.9	5.1	6.73	13.4	8.8
3d "	143.2	4.5	6.44	12.9	9.0
4th "	136.2	4.8	6.54	10.4	10.2
Total.....	534.8	4.93	26.38		

Received cold pressed cake.

Second Period.

	Lbs. Milk.	Average Pct. Fat.	Total Butter Fat, Lbs.	Average Feed Consumed Daily: Ration 1a.	Ration 2a.
5th week....	148.2	4.6	6.82	10.0	9.8
6th "	159.7	4.6	7.35	8.7	10.4
7th "	159.1	4.7	7.48	7.5	11.4
8th "	162.8	4.6	7.49	6.3	11.4
Total.....	629.8	4.63	29.14		

Received cotton-seed meal and hulls.

The above record shows a big difference in favor of the cotton-seed meal and hull ration—there being a difference of 95 lbs. of milk in its favor; the per cent fat and total butterfat being about the same in each case.

Reviewing both lots, the cotton-seed meal ration produced more milk in every individual case, with two exceptions. The butterfat production remained about the same in each case.

In the following table is shown the amount of food consumed by each cow; also, amount of milk produced, amount of butterfat and butter produced, and amount of milk produced to every one pound of concentrates fed:

TABLE XIV.

Lot 1, First Period.

	Alfalfa.	Hulls.	Cotton Seed. Meal.	Hulls.	C. Meal.	Pounds Milk.	Pounds Milk Produced to 1 Lb. Contrate Fed.	Butter Fat.	Estimated Butter.
Jennie	126.4	254.9	58.1	28.7	86.8	360.3	2.075	16.75	19.54
Annie........	148.8	297.6	82.6	41.3	123.9	519.3	2.096	21.54	25.13
Lizer.........	132.5	266.0	101.5	51.1	152.6	627.2	2.055	24.60	28.70
Scrappie......	118.0	236.7	86.1	42.0	128.1	570.7	2.098	24.47	28.55
Mary	160.0	319.3	146.3	72.8	219.1	901.8	2.058	29.72	34.67
Cricket	126.4	246.5	88.9	44.8	133.7	555.7	2.078	23.85	27.83

Lot One, Second Period.

	Alfalfa.	Hulls.	Cold Pressed Cake.	Hulls.	C. Meal.	Pounds Milk.	Pounds Milk Produced to 1 Lb. Contrate Fed.	Butter Fat.	Estimated Butter.
Jennie	94.4	186.2	90.3	...	190.3	356.5	1.974	15.77	18.40
Annie........	105.7	210.1	128.8	...	128.8	499.8	1.940	19.73	23.02
Lizer.........	100.4	193.4	147.2	...	147.2	562.8	1.912	22.64	26.41
Scrappie......	76.7	153.9	152.6	...	152.6	607.6	1.991	25.64	29.91
Mary	117.1	235.0	212.5	...	212.5	802.9	1.889	27.57	32.17
Cricket	89.7	174.0	137.8	...	137.8	528.9	1.919	22.22	25 92

Lot Two, First Period.

	Alfalfa.	Hulls.	Cold Pressed Cake.	Hulls.	C. Meal.	Pounds Milk.	Pounds Milk Produced to 1 Lb. Con-trate Fed.	Butter Fat.	Estimated Butter.
A. Bell	126.4	252.8	139.3	...	138.6	575.4	2.071	24.02	28.02
Alice	143.2	289.2	150.5	...	150.5	634.5	2.108	27.74	32.36
Bob	115.2	230.4	130.2	...	129.0	554.5	2.139	24.23	28.27
Blackie	148.8	297.6	186.9	...	186.9	807.6	2.161	27.22	31.76
Nellie	154.4	311.3	158.9	...	158.2	668.0	2.106	26.52	30.94
A. Laurie	118.0	233.2	129.5	...	129.5	534.8	2.060	26.38	30.78

Lot Two, Second Period.

	Alfalfa.	Hulls.	Cotton Seed. Meal.	Hulls.	C. Meal.	Pounds Milk.	Pounds Milk Produced to 1 Lb. Con-trate Fed.	Butter Fat.	Estimated Butter.
A. Bell	92.4	180.6	94.5	46.2	140.7	573.1	2.037	23.93	27.92
Alice	104.4	207.7	105.7	52.5	158.2	635.2	2.008	25.25	29.46
Bob	87.4	173.4	102.0	44.8	146.8	586.0	1.996	23.58	27.51
Blackie	123.4	247.6	152.3	75.4	227.7	923.7	2.028	29.80	34.77
Nellie	114.2	227.3	118.3	58.0	176.3	695.5	1.972	26.07	30.41
A. Laurie	76.7	151.2	100.3	50.4	150.7	629.8	2.090	29.14	34.00

TABLE XV.

Totals Lot No. 1.

	Alfalfa.	Hulls.	Cotton-Seed Meal and Hull Mixture.	Corn Meal.	Pounds Milk.	Butter Fat.	Estimated Butter.
First Period..........	812.1	1621.0	844.2	844.2	3535.0	140.93	164.42
	Alfalfa.	Hulls.	Cold pressed Cake.	Corn Meal.	Pounds Milk.	Butter Fat.	Estimated. Butter.
Second Period.........	584.0	1152.6	869.2	869.2	3358.5	133.57	155.83

Totals Lot 2.

	Alfalfa.	Hulls.	Cold pressed Cake.	Corn Meal.	Pounds Milk.	Butter Fat.	Estimated. Butter.
First Period..........	806.0	1614.8	895.3	892.7	3774.8	156.11	182.13
	Alfalfa.	Hulls.	Cotton-Seed Meal and Hull Mixture.	Corn Meal.	Pounds Milk.	Butter Fat.	Estimated Butter.
Second Period.........	598.5	1188.8	1000.4	1000.4	4043.3	157.77	184.07
Totals of lots receiving C. S. M. and hull mixture...........	1410.6	2809.8	1844.6	1844.6	7578.3	298.70	348.49
	Alfalfa.	Hulls.	Cold pressed Cake.	Corn Meal.	Pounds Milk.	Butter Fat.	Estimated. Butter.
Totals of lots receiving cold pressed cake.	1390.0	2767.4	1764.5	1761.9	7133.3	289.68	337.96
DIFFERENCES......	20.6	42.4	80.1	82.7	445.0	9.02	10.53

In the following tables are given the number of gallons of milk produced, value of milk produced, cost of production and profits from each cow during the two periods. In computing the gallons of milk, 8.6 lbs. is counted for a gallon, and in figuring the value, 23 cents per gallon is the average price received by the owner for milk produced. In computing the cost of production, the following prices for feed were reckoned: Alfalfa hay, $21; hulls, $8; cotton-seed meal, $26; cold pressed cake, $24; corn meal, $30, per ton.

TABLE XVI.

Lot 1, First Period.

	Pounds Milk.	Gallons Milk.	Value.	Cost.	Profit.
Jennie	360.3	41.89	$9.63	$4.51	$5.12
Annie.... ...	519.3	60.38	13.88	5.85	8.03
Lizer	627.2	72.93	16.77	6.26	10.51
Scrappie	570.7	66.36	15.26	5.38	9.88
Mary..... ...	901.8	104.86	24.11	8.43	15.68
Cricket	555.7	64.61	14.86	5.65	9.21
Total....	3535.0	411.03	$94.51	$36.08	$58.43

Received cotton-seed meal and hulls.

Lot 1, Second Period.

	Pounds Milk.	Gallons Milk.	Value.	Cost.	Profit.
Jennie	356.5	41.45	$9.53	$4.17	$5.36
Annie.... ...	499.8	58.11	13.36	5.42	7.94
Lizer	562.8	65.44	15.05	5.80	9.25
Scrappie	607.6	70.65	16.24	5.54	10.70
Mary	802.9	93.36	21.47	7.90	13.57
Cricket	528.9	61.50	14.14	5.35	8.79
Total....	3358.5	390.51	$89.79	$34.18	$55.61

Received cold pressed cake.

Lot 2, First Period.

	Pounds Milk.	Gallons Milk.	Value.	Cost.	Profit.
A. Bell.......	575.4	66.90	$15.38	$6.08	$9.30
Alice	634.5	73.78	16.96	6.72	10.24
Bob	554.5	64.47	14.82	5.62	9.20
Blackie	807.6	93.90	21.59	7.79	13.80
Nellie	668.0	77.67	17.86	7.14	10.72
A. Laurie....	534.8	62.18	14.30	5.66	8.64
Total....	3774.8	438.90	$100.91	$39.01	$61.90

Received cold pressed cake.

Lot 2, Second Period.

	Pounds Milk.	Gallons Milk.	Value.	Cost.	Profit.
A. Bell.....	573.1	66.64	$15.32	$5.21	$10.11
Alice	635.2	73.86	16.98	5.88	11.10
Bob	586.0	68.14	15.67	5.31	10.36
Blackie	923.7	107.40	24.70	7.98	16.72
Nellie	695.5	80.87	18.60	6.52	12.08
A. Laurie....	629.8	73.23	16.61	5.17	11.44
Total....	4043.3	470.14	$107.88	$36.07	$71.81

Received cotton-seed meal and hulls.

In the case of Lot 1, in the above tables, the cotton-seed meal and hull ration produced 3535 lbs. of milk during the first period, while in the second period cold pressed cake produced 3358.5 lbs., or a difference of 176.5 lbs. in favor of the cotton-seed meal and hull ration. The cotton-seed meal and hull ration also shows a profit of $2.82 in its favor.

In the records of lot 2, the cotton-seed meal and hull ration produced 4043.3 lbs. of milk, against 3774.8 lbs. produced by the cold pressed cake ration, which shows a difference in milk production of 268.5 lbs. in favor of the cotton-seed meal and hull ration. In this case, the cotton-seed meal and hull ration shows a profit of $9.81 in its favor.

Summing up Lots 1 and 2, in both cases the cotton-seed meal and hull ration produced more milk and gave more profit than the cold pressed cake ration. Taking both Lots, the cotton-seed meal ration shows a total of 445 lbs. of milk and a profit of $12.63 in its favor.

CONCLUSIONS.

Cold pressed cotton-seed cake is not as valuable for milk and butter production as an equal weight of choice cotton-seed meal and hulls mixed in the proportion of two parts of meal to one part of hulls.

The analysis of cold pressed cake is a reliable indication of its feeding value.

When hulls are worth the prices given at the top of the following table and choice cotton-seed meal is worth the prices given at the left, cold pressed cotton-seed cake is worth not more than the figures given in the body of the table:

TABLE XVII.

	HULLS					
	$5	$6	$7	$8	$9	$10
MEAL.	COLD PRESSED CAKE					
$23.....	$17.00	$17.35	$17.65	$18.00	$18.35	$18.65
24.....	17.65	18.00	18.35	18.65	19.00	19.35
25.....	18.35	18.65	19.00	19.35	19.65	20.00
26.....	19.00	19.35	19.65	20.00	20.35	20.65
27.....	19.65	20.00	20.35	20.65	21.00	21.35
28.....	20.35	20.65	21.00	21.35	21.65	22.00
29.....	21.00	21.35	21.65	22.00	22.35	22.65
30.....	21.65	22.00	22.35	22.65	23.00	23.35
31.....	22.35	22.65	23.00	23.35	23.65	24.00
32.....	23.00	23.35	23.65	24.00	24.35	24.65
33.....	23.65	24.00	24.35	24.65	25.00	25.35

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Agricultural Experiment Station

OF THE

Louisiana State University
and A. & M. College,

BATON ROUGE.

Rotation Experiments with
COTTON, CORN, COW PEAS AND OATS.

BY

W. R. DODSON, Director.

BATON ROUGE
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Rotation Experiments

WITH

Cotton, Corn, Cow Peas and Oats

BY

W. R. DODSON, Director.

It is generally conceded that the major portion of the cotton producing land is gradually growing less productive under the prevailing system of cropping. Most men agree that some regular system of rotation is to be commended in preference to continuous cropping in cotton or occasional shifting to corn and cow peas, or allowing the land to lie idle for a year or more at a time. Notwithstanding this general conviction, little progress has been made in the adoption of a definite system of rotation of crops. It is reasonable to suppose that the average man will follow that course which he feels will give him the greatest returns for the labor and capital involved, and if he does not follow a system of rotation, it is because he has not been fully convinced of its practicability and profitableness. Of course, the preservation of soil fertility is an important factor in considering this question. In some instances, no doubt, land owners do not have sufficient knowledge regarding the cultivation and the influence on soil of other crops than cotton to justify them in undertaking to carry out a definite rotation, and tenants, too often, have little or no regard for the future condition or producing power of the soil. It is also true that many of our people have considered our soils inexhaustible, and have taken no precautions to replace any of the plant food consumed by the cotton crop. Others have excused themselves in the belief that available labor was suited only for cotton production. In many instances the question of securing money on the crop in advance of its harvest has encouraged the production of cotton to the exclusion of other crops. Whatever may have been the consideration, when the subject of rotation has been discussed, it has almost invariably ended in the decision that it was easier or more profitable to place one's dependence upon cotton. And so we have gone on from year to year, and probably should have continued as long as the soil would produce enough to make a living for those who cultivate it; but a new condition has arisen because of the invasion of the Mexican cotton boll weevil, and there is an active interest in crops other than cotton, that may be used as substitute crops, or for reducing the expenditure on the cotton crop, or that will aid in other ways in making cotton profitable under boll weevil conditions. For these reasons it has seemed timely to give a resume of some rotation experiments that have been carried on at Baton Rouge and at Calhoun for an extended priod of time. Some of the results have been previously published ,but data has now been extended over such a number of years that deductions will be more reliable, and it is confidently believed that some modification of the rotation given here will be applicable and desirable for many individuals in Louisiana.

PLAN OF ROTATION.

The rotation was originally planned by Dr. W. C. Stubbs, and the results have been so satisfactory that but little change has been made in the original plan.

The experiments have been conducted on six acres at Baton Rouge, and a fraction less than six acres at Calhoun, devoted exclusively to these investigations. One-third of the area is planted each year to cotton, one--third to corn, with cow peas in the corn, and one-third to rust-proof oats, also with cow peas sown after the oats are harvested. The area in cotton any one year is planted in corn and peas the following year; the area in corn and peas is planted to oats in October or early November; the area in oats and peas is planted in cotton the succeeding year. Thus, in three years each plot of land has produced one crop of cotton, one of corn, one of oats and two of cow peas.

One-half of each plot was well fertilized, as hereafter described, and the other half was dependent upon the rotation and the cow peas for the maintenance of fertility up to 1907, when acid phosphate, 150 pounds per acr,e was added to the pea crops.

We will first give the method of fertilizing the plots and the tabulated yields at Calhoun, La.

FERTILIZER FOR ROTATION CROPS.

AT CALHOUN, LA.

The cotton was fertilized with 30 bushels per acre of compost made by the following formula:

2 tons of acid phosphate.
100 bushels of stable manure.
100 bushels of green cotton seed.

The corn was fertilized with 30 bushels per acre of compost made of

1 ton of acid phosphate.
100 bushels of stable manure.
100 bushels of green cotton seed.

The oats were fertilized with 200 pounds of cotton seed meal and 100 pounds of acid phosphate per acre. The peas were fertilized with 50 pounds of acid phosphate and 50 pounds of kainit.

The field was originally covered with pine timber, but had been exhausted by long-continued cultivation in cotton.

The compost is made by putting down a layer of stable manure, about five bushels in a suitable pen or enclosure, then five bushels of green cotton seed thoroughly wet, then 100 pounds of acid phosphate, or 50 pounds, as the formula may call for, is spread in an even layer; another layer of stable manure is then put on and the process continued until the compost heap is completed. After fermentation has progressed two or three weeks the compost heap is cut in slices from top to bottom with a spade and the whole thoroughly mixed. In a few days after this mixing the compost is ready for use. The compost is applied in the drill on which the row is made just before planting.

In 1907 we modified the plan to the extent of adding acid phosphate to each crop of cow peas on the unfertilized area. The crop of peas in 1907 and 1908, and corn and cotton of 1908 have shown marked improvement as a result. We have also added vetch and clover to the seeding in oats, thus utilizing another legume to increase the nitrogen in the soil.

The following results have been secured during the past nineteen years:

TABLE I.

	COTTON		CORN		OATS	
	Yield Seed Cotton		Yield Bushels		Yield Bushels	
	Fertilized	Unfertilized	Fertilized	Unfertilized	Fertilized	Unfertilized
Plot A	....	....	24.4	6.1	12	7.2
	1558	331	28.0	20.6	55.2	25.5
	1509	386	24.4	6.14	47.0	25.0
	1694	413	....	....	51.5	18.5
	1358	500	29.5	6.2	55.0	29.0
	1698	291	40.0	6.0	38.0	12.5
	1513	834	....	....	....	.....
Average	1555	459	30.4	9.75	49.3	22.1
Including 1889	....	....	29.3	9.00	43.1	19.6
Plot B	829	528	....	....	....	.....
	1719	620	34.3	14.6	24.5	8.6
	2018	398	29.3	4.8	40.0	22.0
	1485	851	38.0	12.0	....	.....
	1898	284	15.9	4.0	20.5	7.7
	1936	382	37.0	5.2	36.0	11.5
	....	....	28.5	12.8	....	.....
Average	1811.2	507	30.5	8.9	32.2	12.4
Including 1889	1647	510.5	....	....	....	.....
Plot C	....	....	17.7	13.0	....	.
	708.0	429	16.8	4.8	47.8	22.5
	1446.4	560	26.0	5.0	14.5	5.5
	....	....	42.0	10.7	37.5	10.2
	1410.0	476	48.0	21.0	70.0	23.0
	1137.0	263	34.7	6.7	44.0	15.5
	....	....	....	....	51.0	13.2
Average	1175.3	432	33.5	9.6	44.1	14.9
Including 1889	....	....	30.8	10.2	....	.....

Plot A was first in oats, B in cotton and C in corn. It will be noted that all crops were light, and that the second year they were very good. The first average given does not include 1889, the year the experiment was inaugurated, nor 1896, the year of great drought. The second average includes 1889.

Reducing these results to averages, we have the following:

TABLE II.

	COTTON		CORN		OATS	
	Yield Seed Cotton—Y'rly av. for 6 years		Yield Bush. yearly Av. for 4 Yrs.		Yield Bush. yearly Av. for 5 Yrs.	
	Fertilized	Unfertilized	Fertilized	Unfertilized	Fertilized	Unfertilized
Plot A..........................	1555.0	459	30.4	9.73	49.3	22.1
	Yearly Average for 5 Years		Yearly Av. for 6 Yrs.		Yearly Av. for 4 Yrs.	
	Fertilized	Unfertilized	Fertilized	Unfertilized	Fertilized	Unfertilized
Plot B..........................	1811.2	507	30.5	8.9	32.2	12.4
	Yearly Average for 4 Years		Yearly Av. for 5 Yrs.		Yearly Av. for 6 Yrs.	
	Fertilized	Unfertilized	Fertilized	Unfertilized	Fertilized	Unfertilized
Plot C..........................	1175.3	432	33.5	9.6	44.1	14.9
Average three plots...........	1513.8	466	31.4	9.41	41.8	16.4

We have omitted the results of 1896, the year of severe drought in North Louisiana, which will be referred to later.

From a direct money standpoint, these results show that cotton has yielded the largest money returns, both in well fertilized and in unfertilized land at Calhoun. Oats and cow peas closely approximate the value of the cotton crop on the unfertilized land, when a reasonable value is put on the hay or the peas produced.

The average of fifteen crops of fertilized cotton is 1513 pounds seed cotton, or a good bale per acre. The average of the unfertilized is 466 pounds of seed cotton, or less than one-third bale per acre. Examining the soils today we find a marked contrast in the physical condition of the land receiving the compost and that which has had no compost. The fertilized plots are mellow and spongy to the tread of the foot, while the unfertilized soil is hard and lifeless.

Let us look at the cost of supplying this fertilizer. We have estimated the cost of the fertilizer for cotton at $5.50 per acre, corn $6.00 per acre, oats, $2.95 per acre. This does not count the labor of making the compost or of applying it to the land.

The fertilizer applied gave an average gain of 1047.8 pounds seed cotton, 21.99 bushels of corn and 25.4 bushels of oats. This means that one acre of land produces more cotton under this method of fertilization than would be produced by three acres in cotton without fertilization. It means that one acre of pine hill land, cultivated for seventy or eighty years here is producing more than the average of two acres throughout the South. However, at the beginning the results would seem discouraging.

The first year Plot A was in oats. The fertilizer gave an increased yield of only 4.8 bushels, at a cost of $2.95. The average of six crops of oats on this plot in nineteen years shows an increase of 25.5 bushels in favor of the fertilized acre, at the same cost. The first time it was in corn there was a net loss of $2.30. By the time it reached oats again it gave a net profit of $10.42 and in corn a profit of $3.13, and the fifth time in corn a profit of $5.63.

The first year Plot C was in corn it resulted in a loss of $3.68, and the second year no loss, and the third time it was in corn it gave a profit of $4.50, and the fourth crop of corn a net profit of $9.63; this change being brought about in twelve years. We take the corn from the fact that the results are more striking, and the crop least profitable from value of the harvest. Possibly it is not altogether fair to take Plot C, as it shows these facts more pronouncedly than the other plots.

I have left out of consideration the results of 1896, the year of the great and unprecedented drought. In 1896, North Louisiana for the first time had a complete failure of crops. Fifty thousand dollars was drawn from the State Treasury to send bread to the hungry. Carloads of provision and grain were donated by generous-hearted people to prevent great suffering. That year the acre of corn fertilized as here described made 10¼ bushels, and the acre of cotton produced 791 pounds seed cotton. The unfertilized acres made absolutely nothing. We may never again have so severe a test of the resistance to drought, but the land on which compost has been used shows to advantage every time there is a deficiency of moisture. We commonly explain this by saying it is due to the vegetable matter incorporated into the soil. Corn of itself may not pay, as well as cotton; oats, and hay crops may not, but they pave the way and prepare the soil for larger yields and more profitable crops of cotton.

On the lands at Calhoun the cow peas do not grow as vigorously as they do in stronger land, and, therefore, the fertilizing value would not be as great.

At Baton Rouge the results are quite different. This is partly due to the fact that the soil is naturally more fertile; partly to the fact that commercial fertilizer alone has been used on the rotation plots, and partly to the presence of black heart in the cotton, reducing the yield. Ten years' experiments at Baton Rouge give the following results:

TABLE III.

	COTTON		CORN		OATS	
	Two Years		Three Years		Four Years	
	Fertilized	Unfertilized	Fertilized	Unfertilized	Fertilized	Unfertilized
Plot A	1488	1181	47.3	31.8	45.4	31.5
	Three Years		Three Years		Three Years	
Plot B	1312	1119	44.4	36.7	42.6	32.7
	Three Years		Two Years		Three Years	
Plot C	928	803	43.7	39.1	51.7	41.5
Average three plots	1242.6	1034.3	45.1	35.8	46.5	35.2

Estimated in dollars and cents, gross receipts for the fertilized areas, the largest money value comes from cotton, being $47.42 per acre, against $43.92 in oats and peas, and $41.00 for corn and peas; counting cotton at 10, oats at 45c, corn at 60c, hay at $14.00 per ton and cotton seed at $14.00.

We shall not go into the cost of producing the various crops, except to say that the cost is not greatly different. The increased cost of seeding and plowing for peas and oats about balances the cost of seeding and cultivating the cotton crop and the corn crop. Of course, the cost of harvesting is against the cotton. On the other hand, the danger of damage of hay from bad weather is much greater than for cotton, yet I believe few of us realize the real losses we suffer in the cotton crop from exposure to bad weather.

However desirable it may be to use the compost here described, this method of fertilization is practicable only to a very limited extent, as it requires stable manure as an ingredient of the compost, and this cannot be secured in large quantities, under our present system of farming. Cotton seed are also advancing in price, and when more than $15.00 can be realized for seed it will be equal to their fertilizing value. Thus, again, we have emphasized the necessity of raising more live stock, that they may consume grain and forage crops, and the meal from our cotton seed, and return the fertilizing ingredients to the soil.

I know of no way of permanently increasing the fertility of the land except through the agency of vegetable matter. I know of no more profitable way of securing this vegetable matter than raising hay and forage crops, feeding it to live stock and applying the resulting manure to the land. Nature has given us a great advantage in preserving the fertilizing elements of our soil if we but heed our opportunities. When we sell cotton lint, we sell cellulose, composed of hydrogen, oxygen and carbon, which was derived from the air and water.

When we sell our seed, we sell the fertility of the land, as the northern and western farmer does when he sells his grain. The oil, however, has no fertilizing value, being, like the lint, composed of elements taken from the air and water, and cannot be used again by the cotton plant; so if we sell only the lint and the oil, returning the hulls and meal to the land, we have not reduced the fertility appreciably.

The utilization of grain crops also makes it easier to adapt labor-saving implements. Grain and hay crops can be harvested by machinery, and the labor rendered less arduous than gathering the cotton crop. The crops herein discussed other than cotton have not paid, in themselves, as brought out in previous figures, as well as the cotton crop, but they have made possible the heavy yields of cotton by increasing the producing power of the soil, and the whole area has, we believe, been as profitable as it would have been if devoted continuously to cotton production, with the aid of commercial fertilizer alone. The advent of the boll weevil makes it necessary to devote a less acreage to cotton, so that the crop can be handled with greater dispatch, and in many instances the system of rotation offered above may prove satisfactory. In case a longer period of rotation is desired it can easily be arranged after the following order:

A FOUR-YEAR ROTATION SYSTEM.

Instead of devoting one-third of the cultivated land to cotton, one may divide the area into four parts, and devote two to cotton, one to corn and peas and one to oats and peas. For illustration, let us say we name the areas A, B, C, and D. Plant A and B in cotton, C in oats and peas and D in corn and peas The following year B and C in cotton, D in oats and peas, A in corn. The third year, C and D in cotton, A in oats and peas, and B in corn. The fourth year, D and A in cotton, B in oats and peas, and C in corn.

The fifth year the arrangement of crops would be the same as the first year. In four years each area would produce two crops of cotton, one of corn, one of oats and two of peas.

The addition of phosphate to the pea crops has seemed advisable from the fact that cow peas may draw upon the air for nitrogen, but no source of phosphoric acid is available except what may be drawn from the subsoil, and experience has shown that this is not sufficient to meet the demands of crops.

The addition of 150 pounds of acid phosphate per acre to each crop of peas has caused the peas to make much more vigorous growth, thereby increasing the amount of nitrogen secured from the air, and also increasing the amount of vegetable matter left in the soil.

VARIETIES OF OATS TO PLANT.

The Stations receive a great many inquiries about varieties of oats. It is almost useless to plant other than genuine rust-proof oats. Seed grown in Louisiana are to be preferred. Much of the seed sold as rust proof by seedsmen is quite subject to rust. Texas produces a considerable quantity of seed oats that are good, but there is danger of securing Johnson grass seed in Texas oats. Strains of oats propagated by J. Burress McGehee, Laurel Hill, Louisiana, and by R. F. Patterson, Baton Rouge, Louisiana, are the most desirable varieties we have cultivated.

PLANTING OATS.

The best results are to be expected by planting oats from the first of October to the first of December. If the field can be pastured during dry weather in the fall and winter, October planting is to be preferred. If the field is not to be pastured, late October or early November is to be preferred. Sow at the rate of one and a half to two bushels to the acre, on well-pulverized soil, and harrow in, or, better, plant with a seed drill, about one and one-half inches deep.

In some soils hairy vetch, red clover or crimson clover makes a desirable combination with oats. A bushel and a half of oats and a half bushel of hairy vetch, or ten pounds of clover seed per acre make a good seeding. Crimson clover is desirable for sandy lands, red clover and vetch for loam soils.

SUPPLEMENTARY FERTILIZATION OF OATS.

In North Louisiana we have found that a top dressing of nitrate of soda, fifty pounds per acre, applied in early spring, has greatly increased the yield. At Baton Rouge we have tried various fertilizers, applied as top dressing, outside the rotation areas, with variable results.

OATS AS A GRAZING CROP.

We have found by grazing test, results of which will be published in detail in another bulletin, that oats are the best crop we can raise for winter grazing, where alfalfa does not thrive. If they are grazed too much, however, the yield of seed is reduced. If the winter is warm, so as to favor rapid growth, early oats should be grazed; otherwise they may become too far advanced and be killed by a sudden freeze. When the stems begin to joint and show evidence of formation of heads, the stage commonly designated as being "in the boot," they are subject to severe damage by light freezes. In retarding excessive growth, grazing is an advantage to the crop.

ADDITIONAL PLANS FOR ROTATION.

A considerable number of systems of rotation that are desirable may be formulated, some of which will include almost any desired crop, and yet have cotton follow one or more crops of legumes, thus utilizing the best effect of the legumes on the cotton crop. The following plans are suggested:

ROTATION OF COTTON, CORN AND PEAS, OATS AND LESPEDEZA.

Let us again divide the total acreage into four equal parts. Plant two parts in cotton, one in corn with cow peas sown in the corn at last plowing, and one part in fall sown oats with Lespedeza sown in the oats in February or early March, at the rate of one bushel per acre, without covering. The oats will be harvested in May, and the stubble and Lespedeza pastured, or a moderate crop of Lespedeza may be harvested in the fall. This plot then remains in Lespedeza the following year.

Where corn and peas have been planted, Lespedeza will be planted each even year of the rotation and in cotton each odd year. Each plot will be in cotton two successive years, then in corn and peas, then in oats and Lespedeza.

The following diagram will represent the arrangement of crops successive years:

Year of Rotation	Field A.	Field B.	Field C.	Field D.
1	Cotton	Cotton	Corn and Peas	Oats and Lespedeza
2	Cotton	Corn and Peas	Cotton	Lespedeza
3	Corn and Peas	Oats and Lespedeza	Cotton	Cotton
4	Cotton	Lespedeza	Corn and Peas	Cotton
5	Cotton	Cotton	Oats and Lespedeza	Corn and Peas
6	Corn and Peas	Cotton	Lespedeza	Cotton

If it is desired, Lespedeza may be left for a third crop, and this would make four crops of legumes between cotton crops on one-fourth of the land.

In some cases on small farms sugar cane can be substituted for Lespedeza as a two-year crop, but of course the effect on the land will be quite different.

SORGHUM, SWEET POTATOES, ETC.

Instead of planting full area to oats, or corn and peas, other crops may be substituted in part or in full. Hairy vetch is a good crop to mix with oats, using a half bushel of seed per acre. Unfortunately, the seed have been rather expensive.

Stock beets and rutabaga turnips make good winter feed for hogs, sheep and cattle. The seed can be planted after the corn crop, and the resulting crop harvested in time to plant cotton. The rutabagas mature in advance of the stock beets, but are not as desirable otherwise.

SPANISH PEANUTS.

Spanish peanuts are a desirable crop for small areas in sandy land, and are valuable in adding fertility to the soil.

Velvet beans are the best crop we can grow for fertilizing purposes, if the plants can be allowed to grow from early spring till checked by frost, and they also are the best crop we can grow for shading out noxious weeds and grasses.

Good crops of German millet can be grown after a crop of oats, but this succession would bring two crops together that draw heavily from the fertility of the soil.

With a little study one will not have much trouble in arranging a system of rotation that will give a leguminous crop on the land at least every third year, or two crops in four years, thus taking advantage of the cheapest possible source of nitrogenous fertilization.

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OF THE

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and A. & M. College,

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Orchard Report of
Baton Rouge Station

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ORCHARD REPORT

OF

Baton Rouge Station

The experiment station test orchard was established at Baton Rouge in 1889-90, and partial reports have been issued from time to time.

Being located in close proximity to both the University and the city of Baton Rouge, there has been more or less difficulty in securing complete data, on account of depredations incident to the nearness of the city. This report will give the observations that have been gathered, and although incomplete, will be sufficiently full to be valuable to one who is interested in fruit, and who lives upon the Bluff soils of the State.

SOIL.

The Bluff soils of Louisiana are not friendly to all fruits. Being tenacious of moisture, as well as highly fertile, some varieties tend to produce excessive vegetation rather than heavy fruiting.

The fruits belonging to the more temperate regions do not possess full hardiness so far as Louisiana conditions are concerned, and becoming weakened by climatic influences, they soon become a prey to various insect and fungous attacks.

Another serious drawback is the uncertain character of the seasons. An open winter may induce very early blooming and subsequent frost will then kill the fruit. Measures adopted in Northern States for retarding the blooming period are not applicable here.

Another source of trouble is the tendency of some trees to overbear. This no doubt is the most prominent cause of the early death of some trees. The only remedy for this is to thin the fruit thoroughly and systematically, a thing that very few people, outside the commercial orchardists, ever practice.

To meet losses sustained, it is necessary to plant some fruit trees every year, so that as they bear and commence to fail, new trees will come into bearing and supply plenty of fruit.

Cultivation in the Station orchard has consisted in keeping the orchard as clean as possible and no fertilization has been given except an occasional crop of peas. Frequent use of the cultivator and plowing when necessary, has accomplished this fairly well. In the rainy portion of the summer it has been difficult to follow, and it is probable that some injury may have resulted by later cultivation, which seemed to be necessary.

Last year a bulletin upon the Japanese persimmons was issued, consequently they will not be treated in this report. Pecans and other nut trees, also, will be treated in a bulletin in the near future. Those interested in nut culture may find Bulletin No. 69, upon pecans, full of information. In all the illustrations in this report, the cards have inch marks, so that one may form a good judgement of the size of the fruit.

APPLES.

Quite a number of varieties of apples have been grown, both of Northern and Southern origin. The results of these tests indicate that apples may be grown in South Louisiana for home use, but they cannot be grown for commercial purposes. It is possible that an apple may originate in some portion of the State that will be hardy in this climate. A very long step in this direction has been accomplished by Mr. John Delee, of Teddy, La., who has been working along this line for many years. His collections of apples of Louisiana and South Mississippi origin contains a number of very desirable sorts. His home, however, is in the sandy uplands, very distinct from the bluff and alluvial lands. Another apple of great merit is the McMullen (see Fig. 2). This apple belongs to the Black Twig family, and while it is supposed by many to be a seedling, it is extremely probable that it is not. This apple is no doubt the best one so far grown in Louisiana and it, too, has been

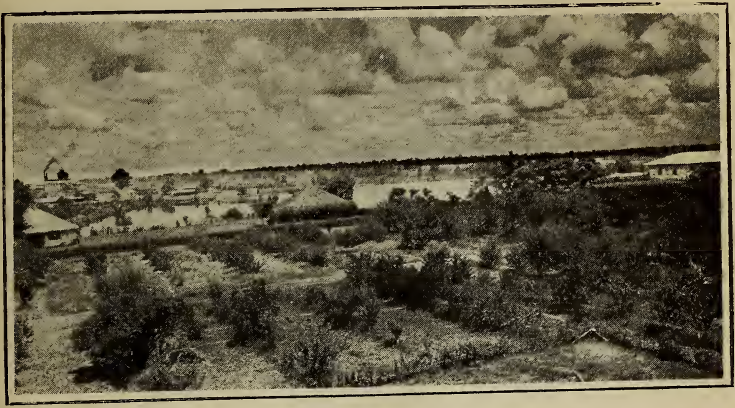


Fig. 1.

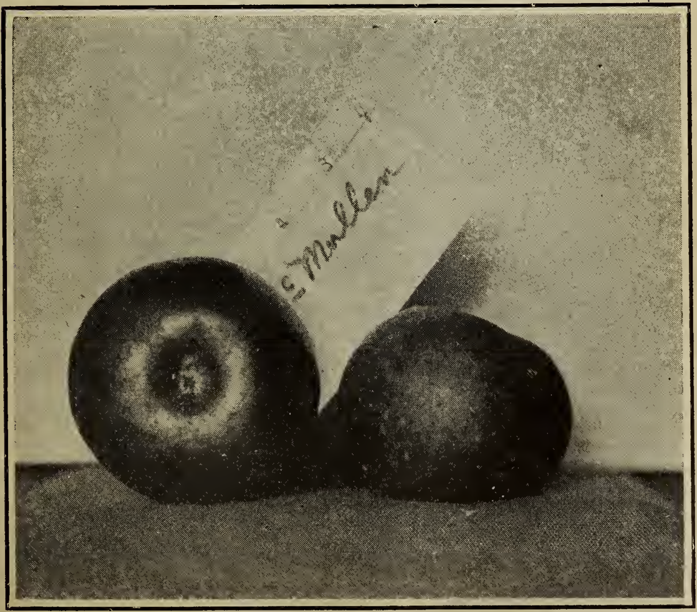


Fig. 2—McMullen Apple.

brought out on the sandy lands, coming from Stonewall, the southern part of Caddo Parish. The original trees were obtained from a traveling tree agent twenty years ago, who supposedly came from South Mississippi. So far as can be seen, the trees are not budded, nor are they grafted, yet as they are all alike, they were no doubt grown from cuttings—a very common practice years ago in the South. Whatever may be ultimately found out concerning the exact origin of this apple, its growth and productiveness in the uplands make it a very valuable home, and possibly a commercial apple for those sections. All these apples mentioned are growing at the Station, but have not fruited. The following varieties have been grown at the Station, all but a few of which have been brought to maturity:

Variety.	Blooming Period.	Ripening Season.	Remarks.
Alexander	March 20-April 10		Failed to bear.
Ben Davis			Has not borne yet.
Bellflower	March 28-April 15	June 15	Very few fruit. Inferior.
Bismark			Not fruited, yet.
Bledsoe	March 30-April 20	July 25	Very fine fruit. Prolific.
Black Warrior	March 20-April 10	July 20	Decayed quickly. Few fruit.
Carolina Watson	March 20-April 10	June 20	Good bearer. Desirable.
Carter's Blue	March 25-April 10	July 20	Bears fairly well.
Cullassago	March 26-April 15	June 20	Shy bearer. Fruit fair
Disharoon	March 20-April 10	July 15	Very few specimens.
Duchess	March 20-30	June 30	Undesirable in bearing and fruit.
Doyle	March 10-30	July 15	Bore few. Quality good.
Early Harvest	March 15-30	June 10	Good bearer. Desirable.
Early Red Margaret	March 15-30	June 20	Poor bearer. Not desirable.
Early Penock			Not fruited yet.
Elgin Pippin	April 5-25	July 20	Poor bearer. Specimens bad.
Family	April 1-15	July 15	Fair bearer. Fruit fair.
Fanny	April 1-15	July 1	Poor bearer. Fruit fair.
Hewes Crab	March 20-April 10	June 20	Very few specimens. Not desirable.
Horse	April 5-29	July 15	Fair bearer. Fruit good.
Hislop	March 17-30	July 10	Poor bearer. Fruit fair.
Julian	April 15-30	June 20	Poor bearer. Fruit fairly good.
Kentucky Streak	March 1-20	July 10	Bears fairly well. Desirable.

Variety.	Blooming Period.	Ripening Season.	Remarks.
Mangum	April 10-25	June 30	Shy bearer. Fruit fair.
McMullen			Not fruited yet.
Maverac Sweet	April 15-29	June 20	Good bearer. Desirable.
May Pippin			Not fruited yet.
Moon			Not fruited yet.
Nantahalee	April 10-30	June 30	Fair bearer. Fruit good.
Pine Stump	March 15-20	July 30	Very few inferior specimens.
Rhodes Orange			Not fruited yet.
Red Astrachan	April 15-30	June 1	Prolific and desirable.
Red June	April 15-30	June 10	Prolific and desirable.
Red Winter			Not fruited yet.
Romanite	April 1-25	July 25	Good bearer. Fruit good.
Rome Beauty	April 20-30	July 20	Fair in yield and fruit.
Rough and Ready			Not fruited yet.
Royal Limbertwig			Not fruited yet.
Rutledge	April 15-30	July 15	Fair in yield and fruit.
Russet	March 20-April 10	July 30	Very few. Not desirable.
Shockley	March 27-April 15	July 15	Fair in yield and fruit.
San Jacinto			Not fruited yet.
Smith	April 15-30	June 15	Very good in yield and fruit.
Sweet Bough	April 15-25		Not fruited yet.
Summer Queen	April 15-30	July 1	Fair in yield and fruit.
Tannton	March 20-30	July 28	Very few but good.

Variety.	Blooming Period.	Ripening Season.	Remarks.
Texas Red	April 15-30		Not fruited yet.
Transcendent	March 10-April 5	June 25	Prolific and desirab
Tuskegee	March 9-23		Not fruited yet.
Tuscaloosa	March 18-30	July 20	Fair in yield and fruit.
Washington Strawberry	April 15-30		Not fruited yet.
Winesap			Not fruited yet.
Yates	March 26-April 15		Not fruited yet.
Yellow Forest	April 1-15	July 10	Fery few. Quality good.
Yellow Transparent	March 20-April 10	June 15	Fery few. Quality good.
Yellow June	March 25-April 10	June 1	Fair in yield and fruit.

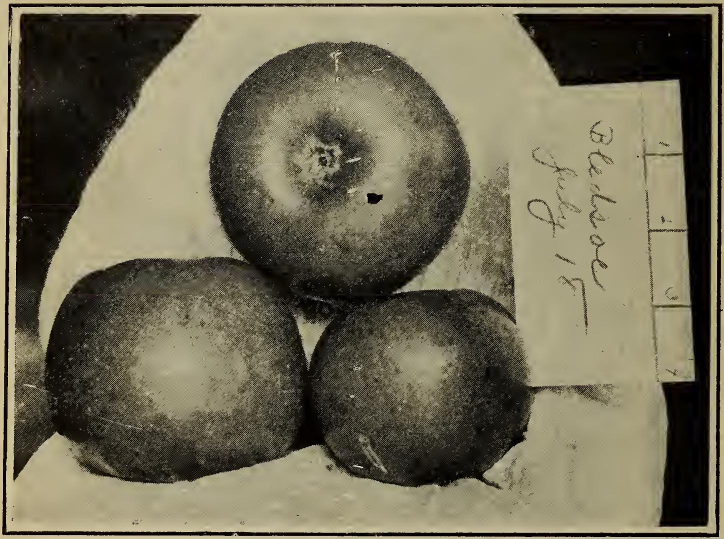


Fig. 3—Bledsoe Apple.

Of the varieties named, there are only a few that are reliable and desirable. The apples recommended at this time are, in the order of their excellence, as follows:

Carolina Watson, a prolific bearer, with large, somewhat flattened striped fruit, coming into season the middle of June.

Red June, a very good bearer, fruit not large, deep red, excellent flavor, season early in June.

Red Astrachan, very good bearer, fruit nearly red, quite acid, medium size, coming into bearing about June 1st.

Early Harvest, a small yellow apple, fairly good bearer, maturing early in June.

Smith, a medium sized, light yellow apple, good bearer, maturing usually early in July.

Bledsoe, very large, fine, quite prolific, season July 25. (See Fig. 3.)

TRANSCENDENT CRAB.

This is a healthy growing, good bearing crab apple, maturing its fruit about July 10th. An excellent fruit for jelly purposes.

While these apples are all early maturing they are all apples of excellence. An apple that matures late in Louisiana has to run the gauntlet of disease, birds and boys, to the end that few late apples ever succeed.

APRICOTS.

The following varieties of apricots have been grown, but they have never produced fruit, nor did any of them live over five years: Early Golden, Moorpark, Royal, Roman, Alexis, Alexander, Peach.

CHERRIES.

A number of cherries have been grown, but none have lived long enough to produce fruit, except the Louisiana Ironclad. This cherry originated in North Louisiana, and was introduced by Mr. A. K. Clingman some years ago. Although it is the only cherry capable of producing fruit to any extent in Louisiana, it is far from being desirable.

FIGS.

Figs constitute the main fruit crop of Louisiana. They are perfectly at home in nearly every section and grow and produce abundant crops without any care or attention. In the event of the extension of the canning industry, fig growing may become of great commercial importance. Being soft, not being able to stand transportation, and not being suitable for commercial drying in this climate, commercial fig growing will depend upon the cannery for development, and it will be the local cannery preserving establishments that will have to handle the crop. The growing of figs for preserving purposes has been on the increase during the last decade. Where canneries are located the fig industry should be permanent and prosperous. Near New Orleans figs are in demand for this purpose, as a large cannery located there takes all the figs that are obtainable. The product finds a ready sale. The demand exceeds the supply, and the grower receives good prices. Preserved figs are almost unknown in the Northern market. The only figs found there are the dried ones. It only requires the introduction of the preserved product to develop a good market for it. More trucking and more canneries to take care of the surplus stock will give an opportunity for disposing of hundreds of bushels of figs that annually are lost in Louisiana. The fig has not been well understood botanically, and there has also been great confusion in the nomenclature. Prof. Gustav Eisen, of California, made a full study of the figs and his investigations have been published. Prof. H. N. Starnes, of the Georgia Experiment Station, also has given the subject exhaustive study, and the following classification o four Southern figs has been taken from his bulletin (Bulletin 61, Georgia Experiment Station) upon fig culture:

The condensed statement below gives the classification and at the same time will explain to many the reason why certain varieties drop their fruit.

There are four forms of flowers:

1. Staminate, or male flowers.

2. Pistillate, or female flowers.

3. Gall flowers, serving as a home for the small fig wasp, the Blastophaga.

4. Mule, or sterile flowers, found almost to the exclusion of the other kinds in our Southern figs.

These peculiarities of the fig naturally divide them into different classes.

Three classes and seven sub-classes have been formulated. As all of our Louisiana figs come under one of these heads, nothing will be said at this time concerning the other classes, except what is necessary for an understanding of the classification as they depend upon the Blastophaga or "fig-wasp" for pollination. As we do not have this insect, there is no necessity for describing them in full. The class of figs then that interests Louisianians is the one designated as Domesticated Figs. It includes all the figs grown in the South. Southern figs produce *pistillate* or *female flowers,* and, *mule* or *sterile* flowers. While they do not produce *staminate* or *male flowers,* nevertheless, they possess the ability to develop an edible product, with no true seed. It is impossible for any of our figs to produce true viable seed, hence unless figs of another class capable of producing seed are grown in Louisiana, one may never expect a variety of figs of Louisiana origin. The different blooming habits of our figs easily separate them into three distinct divisions.

Class 1—*Mission Figs,* capable of producing both an early and a late crop.

Class 2—*Adriatic Figs,* capable of producing a late crop, but dropping all of its first crop.

Class 3—*San Pedro Figs,* capable of producing an early crop, but dropping all of its late crop.

The *sterile* or *mule flowers,* are the ones that develop into our edible fig. The *pistillate* or *female flowers,* invariably drop off.

In the Mission class of figs the *sterile* or *mule* blooms predominate in both its *early* and *late* crops, hence, climatic conditions being favorable, two crops of figs may be obtained.

In the *Adriatic Figs* the *pistillate* or *female* blooms predominate in the *early* crop, and the *sterile* or *mule* blooms predominate in the *late* crop, hence the *early* crop drops, and the *late* crop matures.

In the San Pedro Figs, the *sterile* or *mule* blooms predominate in the *early* crop, and the *pistillate* or *felame* blooms predominate in the *late* crop, hence the *early* crop matures and the *late* crop drops.

Occasionally *sterile* or *mule* blooms on both the early crop of the Adriatic type of figs and the late crop of the San Pedro type of figs may develop into edible fruit.

It will be seen by this that the weather conditions have a great deal to do with the crop of figs. It also explains the dropping of figs to a very large extent.

Figs are universally propagated by means of cuttings, which seldom fail to grow. In rare instances, they have been ring budded, but the great readiness with which fig cuttings grow makes it unnecessary for any other method to be used.

A large number of varieties, obtained from various sources, have been grown. A number of them from California, have been growing several years, and while often times loaded with fruit, seldom produce an edible fig.

Some varieties are known under many different names, and varieties obtained from different sources, prove to be well-known varieties under new names. This confusion in time will be eliminated. The following varieties have been grown at the Station. The names are those which came with them from different sources. Some of these names no doubt are incorrectly spelled, but are given as they were received. It must be remembered also that soils and location have everything to do with the behavior of figs, and a fig that does well or poorly at Baton Rouge may do differently under different soils and conditions in other parts of the State.

VARIETIES.

Agen—This is a medium sized, white, deep red fleshed fig. Season, August. Not particularly desirable.

Angelique (Fig. 4)—A round, white, white fleshed fig. Medium size, good flavor. Not a strong grower. Season, middle of July.

Black Dattato—Has never fruited. Evidently belongs to the San Pedro type.

Black Marsailles—A small, black, light rose fleshed fig. Very prolific. Too small for use. Season early in July.

Black California—Same as Mission.

Black Bourgassotte—A large, oblong, brown, red fleshed fig; never has borne to amount to anything. Very late.

Black Brogiotto—Never fruited; probably belongs to the San Pedro type.

Brianzola—Another variety which fails to bear. Evidently belongs to the San Pedro type.

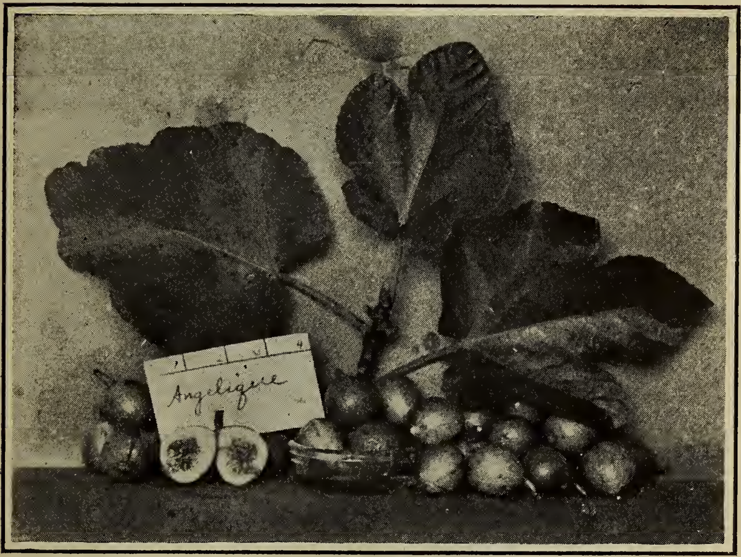


Fig. 4—Angelique Fig.

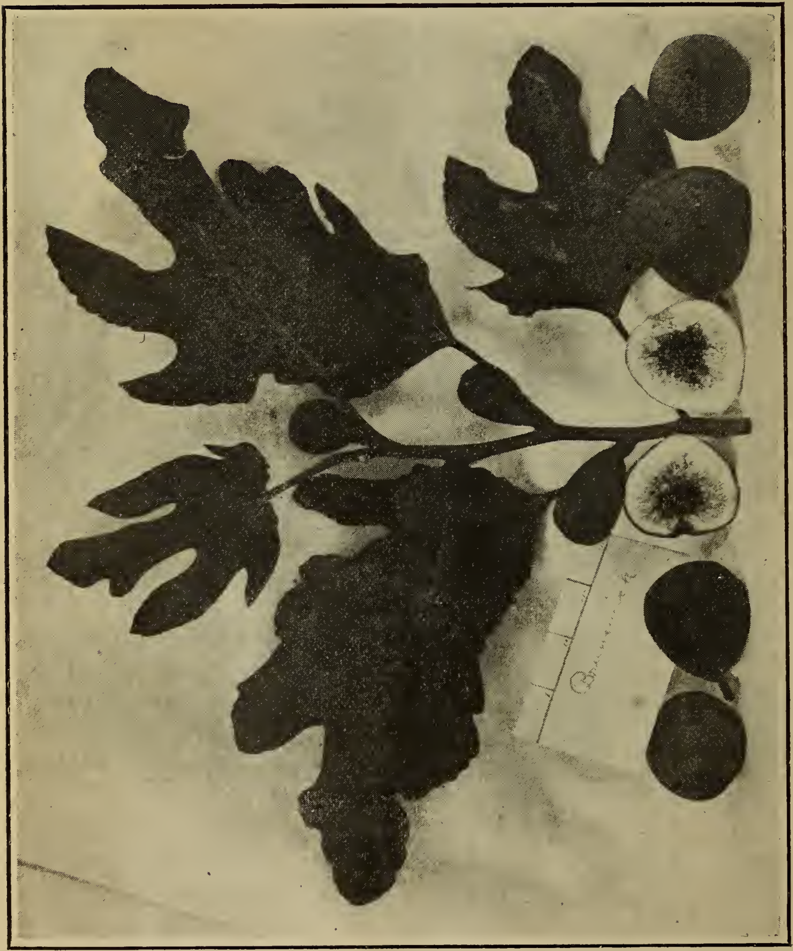


Fig. 5—Brunswick Fig.

Brown Ischia—Same as Brunswick, Brown Turkey, Mandana, and Smyrna, in the collections at the Station.

Brown Turkey—This variety is not true to name, from descriptions given for it. (See Brunswick.)

Brunswick (See Fig 5)—Same as Brown Ischia, Brown Turkey, Smyrna, and Mandana, as sent to the Station from various sources. A very large, dark brown fig with light red flesh. Shape rather oblong and apt to be one-sided. Very prolific, and quite desirable, season the middle of July.

Capri—The wild fig, obtained from California, to plant with the true Smyrna. Useless except for experimental purposes.

Celeste or Celestial (Fig. 6)—The little "Blue Fig" that is grown universally in Louisiana. By far the hardiest, and all around best fig grown. Fruit is small, color a lavendar blush, very sweet, and pronounced in flavor. May be eaten without peeling when fully ripened.

De Constantine—A large, violet brown, somewhat flattened fig with deep red flesh. Quite prolific. Season, the middle of August. Not a desirable fig, as it lacks flavor. A canning variety.

Drop d'Or (Fig. 7)—A small, round, yellow fig, with rose-colored flesh. Very sweet, and melts in the mouth. Splits open badly when weather is damp. A very delicious fig, but a weak grower.

Dalmantino—This variety has not borne fruit, evidently not a Southern fig. Probably belongs to the San Pedro type.

Early Violet—A white-fleshed, brownish fig. Has not done well. Has borne but little fruit. Not at all desirable, if the trees in the orchard are true to name. Season the latter part of July.

Guigliono—A large fig with deep red flesh. Very late and not at all reliable or desirable.

Honche de Bray—A round, yellow, cream-fleshed fig with slight cavity when ripe. Very delicious. Season the last of July. Very prolific. Has a tendency to sour quickly.

Lemon—The variety grown under this name proved to be identical with the Celeste, hence is not true. The Lemon Fig as grown in certain parts of Louisiana is a very desirable fig.

Mandana—See Brunswick.

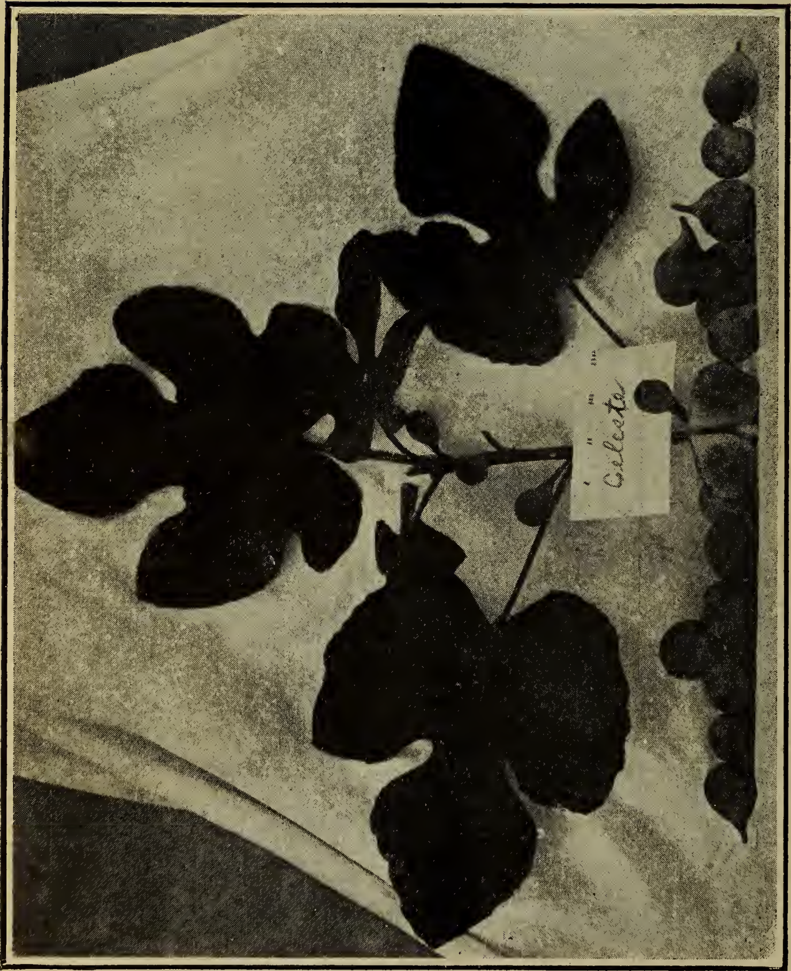


Fig. 6—Celeste Fig.

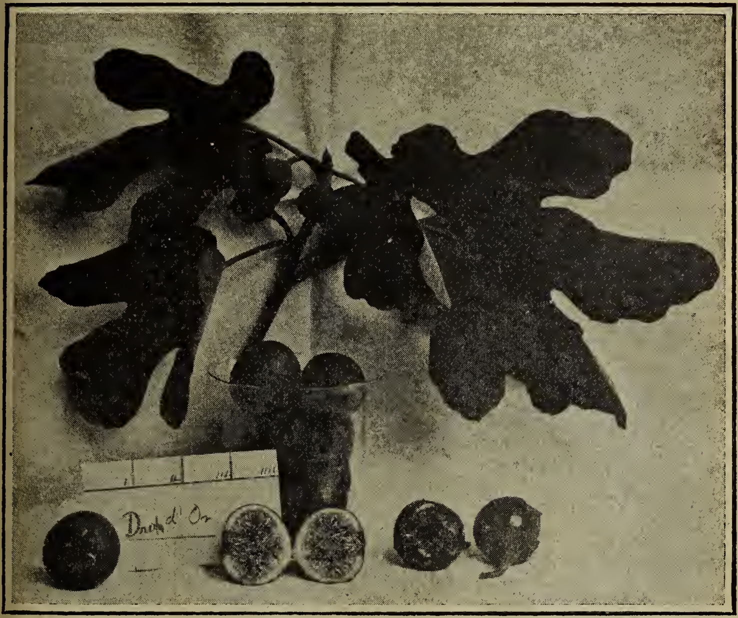


Fig. 7—Drop d'Or Fig.

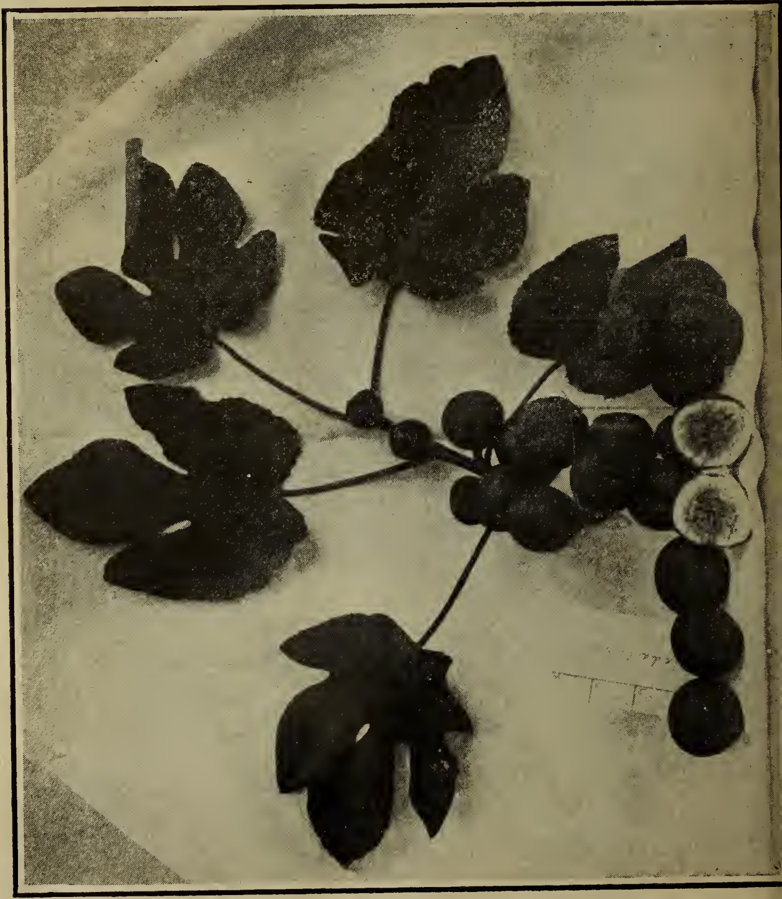
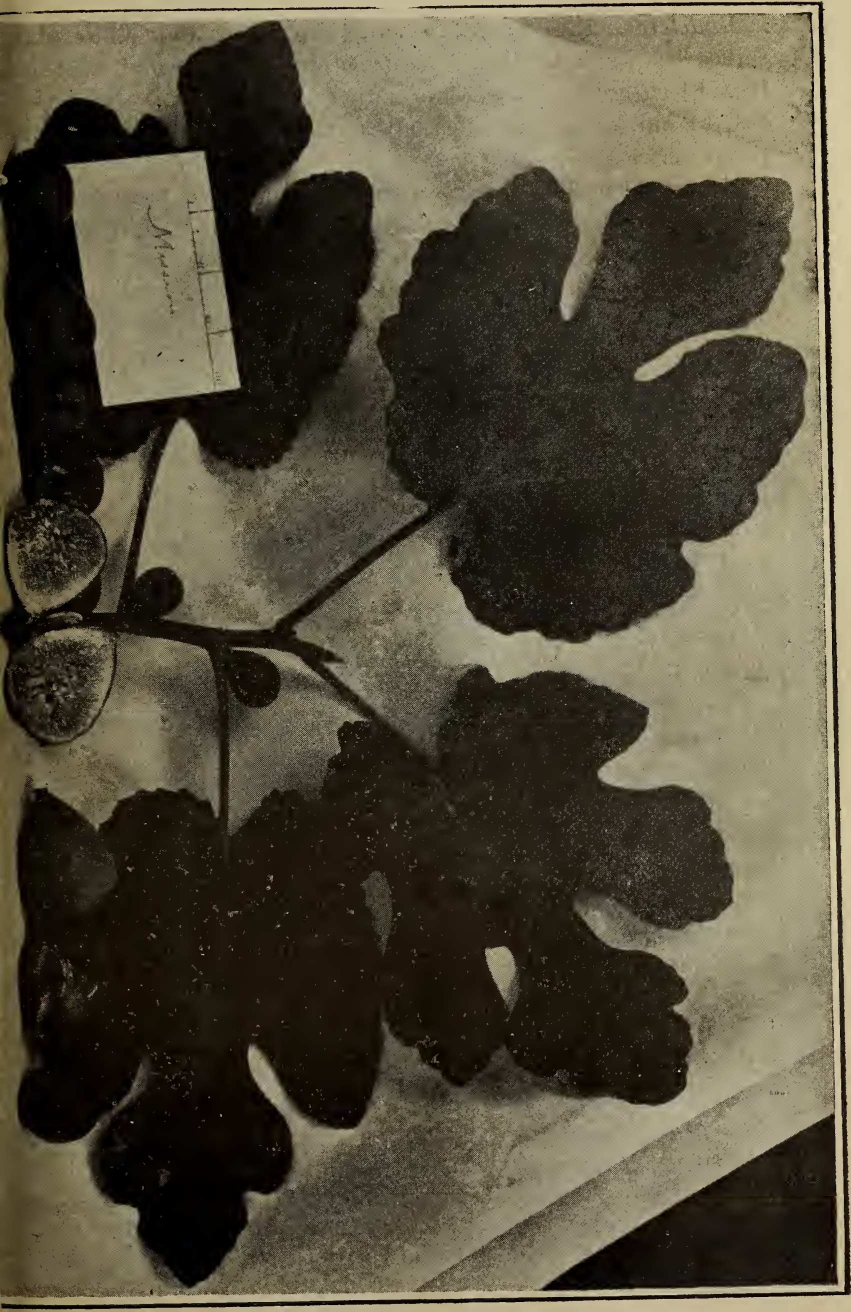


Fig. 8—Madeline Fig.


Mission

Madeleine (Fig. 8)—Same as White Neyri and White Marsailles, as we have them. A large white, somewhat flattened fig. Flesh cream white. Skin rather thin. Very prolific. The best of our white figs. Season early in July and ripening for three weeks.

Mission (Fig 9)—Same as Black California. A medium sized, oblong, black fig, with rose-colored flesh. Season middle of July. Quite prolific, very sweet and the best of the black figs.

Monica Bianca—A large, white, somewhat flattened fig, with deep red flesh. Very prolific and quite desirable, except that in moist weather it splits badly. Season the middle of July. Seems to do better in South Louisiana than at Baton Rouge.

New French—A medium-sized, nearly round fig, with cream-colored flesh. Very sweet and very delicious. Season middle of July. Splits very badly in wet weather, but a very desirable fig. Quite prolific.

Osborne's Prolific (Fig. 10)—Same as White Persian. This is an oblong, short-stemmed fig. Brown at the tip, shaded to amber at the base. Quite large, flesh transparent and cream-colored. Very prolific, splits badly. Season the middle of July and continues for two weeks.

Projans—A very late, white fig, not suited to our conditions. Seldom bears and is worthless.

Reine Blanche (Fig. 11)—This is a medium-sized, rather round fig, with pink flesh. A solid, desirable, prolific fig. Season early in July. One of the best figs in the orchard.

Rubado—A medium-sized, red-fleshed fig. Very late and extremelely uncertain. Worthless.

Sanvito—Has not borne fruit. Evidently belongs to the San Pedro type.

San Pedro—Whether this variety is the true San Pedro is doubtful, yet it bears very early in June when it bears at all and may be true. A few medium-sized white-fleshed. white figs have been produced. Worthless.

Smyrna—The variety secured under this name is identical with the Brunswick as we have it. Not the genuine Smyrna.

True Smyrna—This variety was obtained with the true Capri for experimental purposes. Has not produced yet. Six years old.

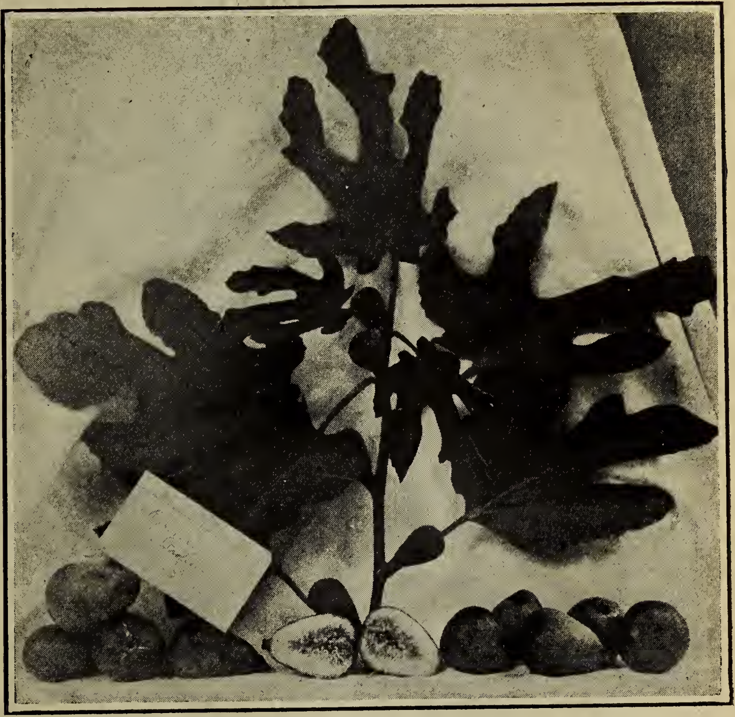


Fig. 10—Osborne's Prolific Fig.

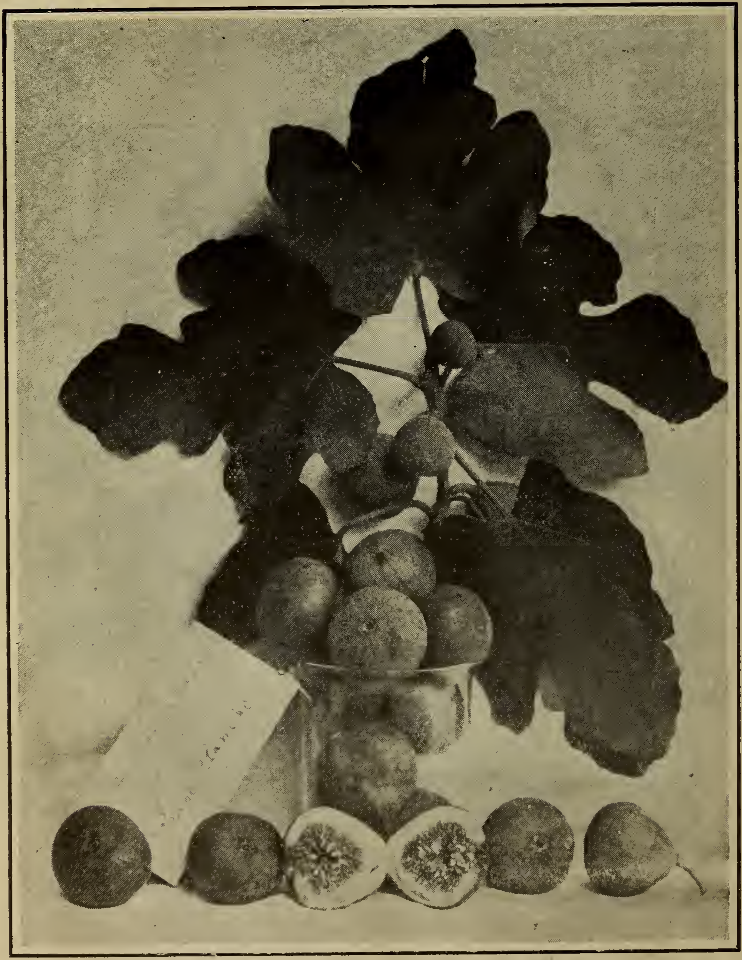


Fig. 11—Reine Blarche Fig.

White Brogiotto—A very late white fig. Almost barren and worthless.

White Bourgassotte—A very large white fig. Very delicious. Belongs to the San Pedro class, as the only time it has ever borne fruit was in 1906, when a few of its first crop matured. Worthless here.

White Dattato—Has failed to fruit. Probably belongs to the San Pedro class.

White Neyri—Same as Madeleine and White Marsailles as we have them. See Madeleine.

White Ischia—A small, round, white fig with cream-colored flesh. Season the last of July. A very sweet fig, and prolific, but not as desirable as a number of others.

White Genoa—A medium-sized yellow fig with amber-colored flesh. Round in shape, fairly good bearer. Season the latter part of July. It is rather doubtful if this is the genuine White Genoa.

White Marsailles—This variety is undoubtedly not true to name, as it is identical with Madeleine as we have them.

White Persian—Same as Osborne's Prolific (which see).

Wonderful (Fig 12)—This is the largest fig in the orchard. Fruit very large, somewhat flattened, contains a cavity generally. Flesh is rose-colored. Not a heavy bearer, but a very vigorous growing tree. Season the middle of July. Not very desirable.

Zimetza—A deep red-fleshed variety. Not certain nor desirable. Seldom bears.

Of all the varieties grown in Louisiana the Celeste is the hardiest, most prolific and most popular. Its one fault is its small size. When dead ripe it may be eaten without peeling. This has been doubted, but when completely ripened, the juice and skin loses its vesicant or irritating qualities, and unless the individual is peculiarly susceptible no ill effect will follow. Some of the Gulf States report that the Brown Turkey is hardier than the Celeste, but this is not the case here. The Celeste, of all the varieties in all portions of the State, has shown the greatest amount of resistance to the cold weather. There are a number of varieties that should be grown for preserving purposes. Among these should be mentioned the Monica Bianca, Madeleine, and Brunswick, while the Mission is very sweet and

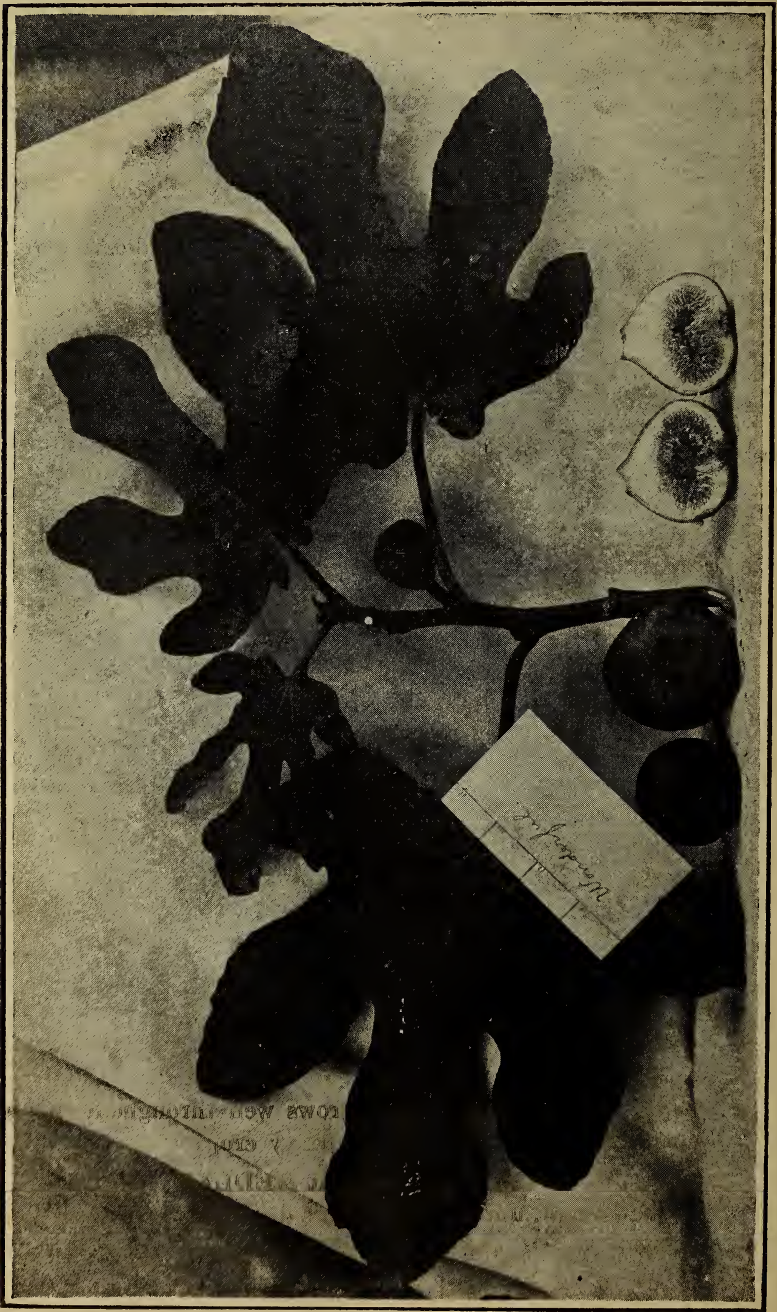


Fig. 12—Wonderful Fig.

answers both the purposes of table and preserving fig. The largest fig in the orchard is the Wonderful, a shy bearer, with fruit three inches in diameter.

GRAPES.

A large number of varities of grapes have been grown, but all have succumbed except a few varieties of the Southern Summer Grape, and Scuppernongs.

The excellent table grapes of the North live but a few years on this soil, generally not longer than to bear two or three crops. Of these the Champion, Diamond, Dracutt Amber, Concord, Niagara, and Moore's Early have proven the best. Of the wine type the Jacquez, Black July, Herbemont, and Ives have grown well and borne heavily.

A small vineyard composed of the improved varieties of Scuppernongs has been established, and as this is the most prominent native grape of Louisiana, growing everywhere luxuriantly, it is full of promise. A few of the varieties have produced fruit. The following varieties are growing in the vineyard and are doing well:

Eden
San Jacinto
Sanmelaska
James
Sanalba
San Monta
La Salle
Sanrubra
Thomas

GOUMI (Eleagnus Longipes).

This peculiar plant is attractive and useful as well. Its large bush-like growth covered with healthy and beautiful foliage, makes it a valuable plant for the lawn as an ornament.

Its very heavy crop of cherry-like fruit makes it desirable for use. It grows readily from cuttings and has no serious enemies or diseases.

JUJUBE (Zizyphus Jujuba).

The Jujube, while grown only as a novelty or curiosity, is relished by a large number of people for the peculiar flavor of its small stone fruit. It grows well throughout this section and usually bears annually a heavy crop.

LOQUAT OR MEDLAR.

The Loquat, universally miscalled the Japanese plum, is grown to some extent and several varieties have been grown in the orchard. It is a very uncertain bearer, as it blooms at Baton Rouge in December and January, and is very often killed by a freeze; yet when it does produce a crop it is highly prized. The small, fig-shaped, juicy, sub-acid, yellow fruit has a delicious flavor. Unfortunately there is a very serious blight which attacks the tree that is very difficult to control. Only a very few varieties have been propagated.

MULBERRIES.

This fruit has received very little attention, but it should be grown more frequently. It is a very rapid grower, a very prolific bearer, and the fruit may be used for various purposes. It should be planted, too, in various places as a food for a large number of birds, that would seek food probably in other portions of the garden. There are a number of varieties to be obtained, but as they become large trees, and the Station ground is limited, only one variety, the Stubbs, has been grown. It is very prolific, good flavored and quite large.

OLIVES.

Olives have been tried repeatedly, but at this Station it is labor thrown away. There are at present three small trees growing in the orchard, but there has been but a few specimens of fruit. In New Orleans they have produced fruit, but there is little or no promise in their growth. It is very improbable that anything can be done with them.

ORANGES.

The commercial orange section of Louisiana is found on the banks of the Mississippi, below New Orleans. In this section are to be found many large orchards in regular bearing. Along the gulf region westward also may be found sections where the hardiest varieties are grown. In all cases the hardy Citrus Trifoliata is used as a stock, and the Satsuma, very largely as a variety. In the largest orchards in the orange section a number af varieties are grown, some of Louisiana origin. These orchards are located close to the levee, and in a measure receive a certain amount of protection from the river. At times smudges are used for frost protection, but this is practiced by only a few. Banking of earth around the trunk of the tree is also practiced to prevent injury from freezes. It is reported that the annual crop approximates 150,000 boxes. Truck is also grown with the oranges and the combination has proven to be very successful.

There have been many efforts to extend the culture of oranges and to obtain hybrids of the Citrus Trifoliata and some sweet orange. The United States Department of Agriculture has sent out several named hybrids of this kind, but so far they have not been sweet, but have been very acid. However, they may be used in the manufacture of ades, especially for summer drinking. These hybrids have been given the name of Citranges, and the following varieties from the United States Department of Agriculture are growing at the Station:

Colman	Morton	Rusk
Rustic	Savage	Willets

Mr. J. L. Normand, of Marksville, has brought out a hybrid of this same kind, which seems to be hardy at Marksville. It is a small sweet orange, and really has no trace of the bitterness of one of its parents. If this variety possesses the hardiness indicated at this time it will be the greatest acquisition yet accomplished with the orange for Louisiana.

The varieties of sweet oranges growing in the orchard are the Satsuma, Bahia and Du Roi. They bore a full crop last year and were not injured by the cold. A few mandarins, tangerines and kumquats were also grown, bearing well.

The use of Citrus Trifoliata as a stock and the Satsuma as a variety in the cooler sections bordering the orange belt will extend orange culture much farther than it is at the present time. With slight protection oranges may be grown quite easily, but failure to protect at the needed time will result in failure.

Besides those mentioned, seedlings from the orange of Northern China are growing at the Station and will be watched with interest.

PEACHES.

Peaches are not long lived in the bluff soils. Twelve to fifteen years is usually the limit, and oftentimes, in case of heavy bearing, much less. The following table gives the list of peaches that have been grown recently, with brief notes of their blooming period, season and general standing:

Variety.	Blooming Period.	Ripening Season.	Remarks.
Alexander	March 19-25	May 1	Yield fair. Fruit inferior.
Alice Haupte	March 16-27	June 15	Yield good. Fruit desirable.
Amora	March 13-22	June 15	Yield good. Fruit desirable.
Admiral Dewey	March 10-20	May 16	Very few. Fruit excellent.
Beauty Blush	March 14-20	June 10	Yield good. Fruit excellent.
Belle of Geogia	March 10-20	June 1	Prolific. One of the best.
Berckmans	March 17-25	June 16	Very few. Not desirable.
Bishop	March 10-27	June 14	Prolific. Fruit fair.
Chilow	March 13-24	June 10	Prolific. Fruit fine.
Crimson Beauty	March 14-24	June 20	Fair yield. Fruit good.
Chinese Cling	March 14-29	July 20	Prolific. An old stand-by.
Champion	March 15-25	June 10	Prolific. Fruit excellent.
Climax	March 18-27	July 10	Yield light. Fruit fair.
Clingmans May	March 13-24	May 15	Yield very light. Not desirable.
Dwarf Japan Blood	March 12-20	May 20	Prolific. Excellent.
Early Tillotson	March 10-27	June 10	Yield fair. Fruit good.
Early Rivers	March 10-25	June 1	Prolific. Excellent.
Early Louisa	March 14-30		Failed to bear.
Early Crawford	March 10-22	June 16	Yield fair. Excellent.
Eatons Gold	March 17-25	July 10	Yield light. Excellent.
Eldred Cling	March 10-27	July 20	Yield good. Excellent.
Emma	March 14-24	June 30	Prolific. Fruit fair.
Excelsior	March 17-25	June 15	Yield light. Fruit good.
Elberta	March 20-30	July 20	Yield medium. Fruit good.

Variety.	Blooming Period.	Ripening Season.	Remarks.
Eureka	March 18-25	July 10	Yield light. Inferior.
Everbearing	March 20-	July 25	Few. Undesirable.
Fleitas	March 13-24	June 15	Yield fair. Fruit fine.
General Lee	March 15-20	June 20	Yield good. Fruit fine.
Greensboro	March 13-24	June 30	Yield fair. Fruit very good.
Hales Early	March 12-21	June 20	Prolific. Fruit good.
Heath	March 16-25	July 10	Yield very light. Fruit fair.
Hynes Surprise	March 20-30	May 30	Yield good. Fruit fair.
Japanese Wonder	March 15-21	June 25	Very fair. Fruit inferi
June Rose	March 13-20	June 20	Yield good. Fruit fine.
Lady Ingold	March 15-25	June 2	Yield light. Fruit good.
Miss Lolo	March 13-27	June 15	Prolific. Excellent.
Mamie Ross	March 17-29	May 15	Prolific. Excellent.
Ray	March 15-25	May 30	Yield light. Fair.
Reeves Favorite	March 15-25	June 3	Yield light. Inferior.
Sneed	March 13-24	May 25	Good yield. Excellent.
Strouts Early	March 10-23	May 10	Prolific. Excellent.
Superb	March 20-28	July 10	Yield fair. Excellent.
Susquehannah	March 18-25	June 23	Light yield. Fair.
Stump the World	April 1-10	June 20	Very few. Fair.
Triumph	March 16-27	May 20	Prolific. Excellent.
Victor	March 14-29	May 30	Prolific. Excellent.
Wonder	April 1-10	June 1	Light yield. Fair.
Yellow Mystery	March 19-25	May 16	Light yield. Good.

Notwithstanding the common opinion that it is not worth while to pay attention to peach trees on the richer lands of Louisiana, a little care in planting and attention given to a few details, good fruit may be obtained.

By selecting a well-drained site and subduing the luxuriant growth, two good crops and two partial crops may be obtained, hence, if a number of young trees are set every year, plenty of peaches may be had for home use. For home planting the following varieties are desirable, in their order of ripening:

Sneed
Belle of Georgia
Elberta
Strouts Early
Triumph
General Lee
Early Rivers
Fleitas
Chinese Cling

The commercial peach section of Louisiana is found in the sand-hill portion of the State, where numerous orchards are now being planted. The Elberta, and other similar large, red-cheeked, yellow-fleshed varieties are being selected for this purpose.

PEARS.

A large number of pears have been grown, but none have fruited except those belonging to the oriental type, and only one of these has withstood the attacks of the pear blight, probably the worst vegetable disease known.

The Smith pear (Fig. 13) has been bearing annually for a number of years and has not failed to produce a crop but once, the season of 1899, when a February freeze killed a great many trees in the South. The Keiffer and Le Conte have fruited, but the blight often kills the trees of each.

The Smith occasionally has a blighted twig, but it withstands the attacks so well that it seems to be practically blight-proof. The fruit of the Smith, like that of all the other sand pears, is hard and never softens. It is a preserving pear, and should be picked before it matures and made into preserves at once.

The Le Conte, when ripened in a cool, dark place becomes very juicy and luscious.

The Keiffer is the largest of the sand pears, and in common with the others, suffers heavily from the blight.

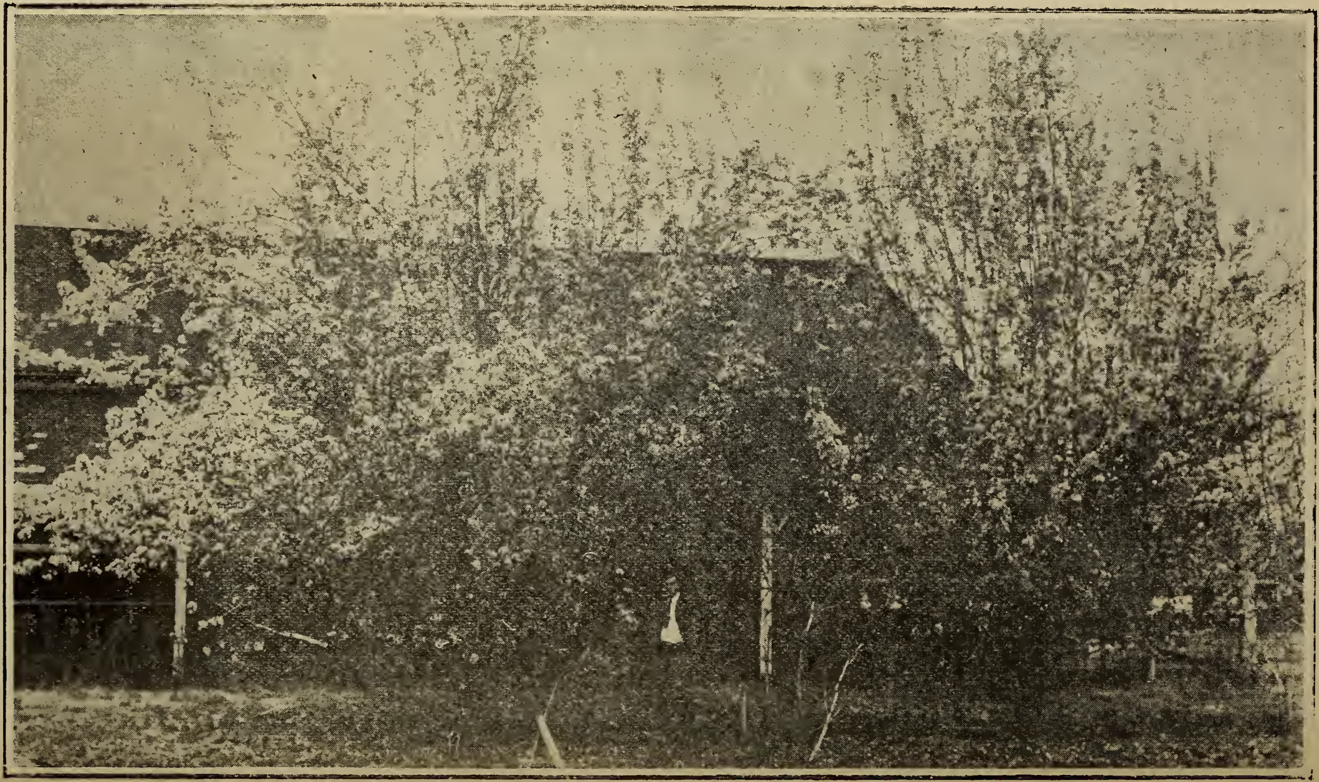


Fig. 13—Smith Pear Trees, in Bloom.

The Smith, from its behavior at the Station, can be recommended very highly and above all the others. The following varieties have been failures:

Alamo	Belle Cluster	Bijou
Daidai	Hawaii	Howell
La France	Lawson	Lexington
Seibold	Ott	Perpetual
Petite Marguerite	Seckel	Winter Nellis

Southern pears are used mainly for preserving purposes. The more delicious European pears, grown in the North for table purposes can not be grown here. The Le Conte, if picked before ripened and placed in a cool dark room will ripen into a fairly desirable pear for table use, but the other varieties of the sand pears are not improved by that practice. They should be picked while quite green in order to obtain the best preserved product. The harder spots found in the maturing pear are absent if this is done. For immediate use as a stewing pear they may be used at any time.

PLUMS.

A large number of varieties of the native, European and Japanese plums have been tried from time to time. None of the European varieties (prunus domestica) have lived to bear fruit. The native and the Japanese varieties have borne well, the latter having a great tendency to overbear.

The Southern native plums are small but very prolific, and are used in very large quantities for jelly and preserves, but the Japanese varieties that succeed best are large, prolific, of fairly good flavor and have a very small pit in proportion to the amount of flesh. Of the Japanese varieties the Abundance and the Burbank lead all the others, and of our native varieties the Pottawattami, Robinson, Munson and Missouri Apricot have borne very well indeed. The following list gives the varieties grown:

Variety.	Blooming Period.	Ripening Season.	Remarks.
America	March 20-30		Has not fruited.
Abundance	March 12-20	June 14	Very prolific. Excellent.
Burbank	March 12-22	June 14	Very prolific. Best.
Botan	March 12-20	June 14	Same as Abundance.
Caddo Chief	March 4-15	July 10	Prolific. Excellent.
Climax			Not fruited yet.
Combination	March 14-28		Has not borne fruit.
Clifford	March 18-24		Has not borne fruit.
Doris	March 14-21	July 1	Very few. Good.
Early Violet	March 18-24		Has not borne fruit.
Excelsior			Has not borne fruit.
Hale	March 12-21		Has not borne fruit.
Kelsey	March 7-19	July 15	Shy bearer. Not desirable.
Munson	March 7-20	May 8	Prolific. Excellent.
Pottowattamie	March 18-25	June 1	Prolific. Excellent.
Red Negate	March 15-22	June 20	Light bearer. Fair.
Robinson	March 12-20	June 25	Very prolific. Good.
Wayland	March 4-20	May 10	Light bearer. Good.
Willard	March 12-22		Has not borne fruit.
Whitaker			Has not borne fruit.
White Kelsey	March 10-21		Has not borne fruit.
Yeddo	March 14-25	June 25	Light yield. Fair.
Mikado	March 12-25	June 8	Light yield. Fair.

POMEGRANATES.

All the pomegranates do well. Several varieties have fruited, and all are hardy. The Sweet seems to be liked the best, although all the varieties are eaten readily. They are propagated easily from cuttings, and have no serious enemies nor diseases up to this time. The following varieties are growing in the orchard:

Papershell
Purple Seeded
Persian
Rhoda
Spanish Ruby (purple seeded)
Sweet

QUINCES.

A few varieties of quinces have been grown, but they have not made a satisfactory growth The trees suffer badly from fungous diseases, and the fruit, ripening so late, almost always decays before it reaches the ripening stage. The varieties grown have been the Angers, Fuller, Meech, and Orange; the last three being the most desirable. The Chinese quince may be grown, but the large coarse fruit is not as useful as the other quinces.

SMALL FRUITS.

All of the small fruits, so-called, have been tried repeatedly. Among the total failures are mentioned the gooseberries, currants and raspberries. These fruits will not thrive in this section. The blackberries, dewberries, and strawberries grow well and are very prolific; the blackberries and dewberries, however, grow so abundantly everywhere that very little or no attention is given to the cultivated varieties.

BLACKBERRIES.

Only a few blackberries have been grown, some of which have thrived and produced well. The following are the varieties:

EARLY HARVEST.

Very prolific, but small. Does not do well in this climate.

EARLY CLUSTER.

Not very prolific nor healthy.

ERIE.

Very desirable berry, but weak grower.

EVERBEARING.'

This is a very vigorous grower, but is very small. It is worthless as a commercial variety.

DALLAS.

Very healthy, prolific and desirable berry; good size and fine.

KITTITINNY.

A very prolific berry but a weak grower, on the whole not long lived.

ROBINSON.

A vigorous grower and prolific bearer. An excellent berry.

HIMALAYA BLACKBERRY.

A new plant sent to the Station by the U. S. Dept. of Agriculture in 1906. It is a vigorous grower, but is worthless as a fruit.

DEWBERRIES.

Several varieties of dewberries have been grown, all of which have succeeded well except the Lucretia, which has been a failure. The following is a list of the varieties:

AUSTIN (MAYES).

This is the best producer grown at the Station. Its berries are not as large as the Manatee, but it is more prolific and the quality is the very best. It comes into bearing by May 15th and continues to bear until June 15th.

BADEN.

A white dewberry of no value.

COLEMAN.

Another white dewberry of no value except as a novelty.

LUCRETIA.

The leading commercial variety of the Middle States. It has been a failure at the Station.

MANATEE.

The largest one of the list. A fine berry, but not as juicy as the Austin.

STRAWBERRIES.

Strawberries may be grown in every section of Louisiana, but in order to carry them through the warmest summer weather some attention must be given to them. The heavier the soil the more difficulty will be experienced, as the growth of grass in the rainy season is luxuriant, and causes considerable trouble. It is almost impossible to keep them in proper shape under the conditions.

Judicious mulching and careful working so as to keep them reasonably clean without disturbing the roots will bring them through the unfavorable season. The region along the Illinois Central Railway is the leading commercial strawberry section and a very large acreage is devoted to them. The shipment of berries from the leading shipping point on their heaviest day reaches nearly thirty car loads. As a rule they pay well, but, like all agricultural and horticultural crops, a great many risks have to be run and some seasons are not very profitable. New beds planted every year give the best berries and are not apt to suffer from pests and diseases as much as old beds.

In the commercial sections, where the type of soil is a very unfertile sand, very heavy applications of fertilizers are given, as well as an abundance of cowpeas grown. The strawberry list in Bulletin No. 52 gives the variety tests up to that time. Since then the effort has been to secure some reliable data upon the yields of our best commercial varieties. The leading commercial variety in Louisiana at the present time is the Klondyke. There are two Klondyke strawberries. One originated in the North and the other in Tangipahoa Parish, La. The Louisiana variety was originated by Mr. R. L. Cloud, who now resides in Hammond, who also brought out the Cloud, one of the best berries we have ever grown. The Klondyke is grown universally in the strawberry section.

The varieties grown have been the Brandywine, Cloud, Klondyke, Lady Thompson (Fig 14), and Michael's Early, but complete records have not been secured. The Lady Thompson has been one of the best berries grown at the Station, fully as good as any grown for all purposes except transportation.

RECORD OF KLONDYKE BERRIES FOR 1908.

	One year old bed.	Two year old bed.
First picking	March 7	March 15
Largest picking	April 8	April 7
Last picking	April 30	April 27

The new bed yielded at the rate of 2,880 quarts and the old bed at the rate of 1,480 quarts per acre.

ORCHARD PESTS, DISEASES AND THE SPRAYER.

Letters are received continuously concerning our most common orchard pests, and diseases, and their treatment. This brief com-

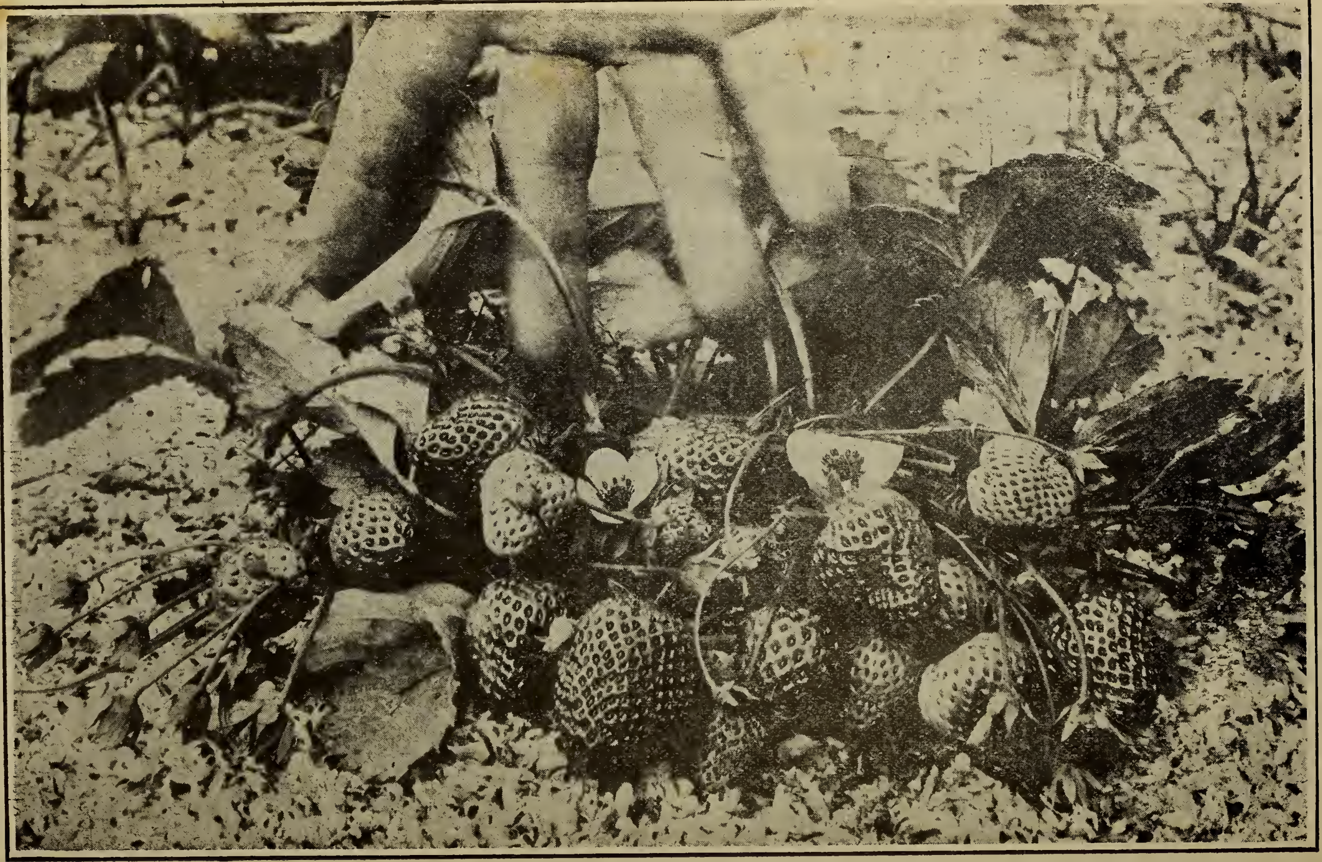


Fig. 14—Lady Thompson Strawberry Plant.

pilation of remedies, taken from the most reliable sources, mainly from Experiment Station Bulletins, is added to the orchard report in order to supply those who receive it with the common remedies for the most prevalent troubles.

In the treatment of these things the spray pump is a necessity. In order to apply treatment, the material must be put on thoroughly and all the parts of the plant covered. This necessitates that it should be spread over the surface of the plant with force. The spray pump with a good pressure maintained insures not only fineness of spray, securing an even application over all the surface, but it also causes the material to adhere. Force and fineness of spray are essential in a spray pump.

There are numerous firms making spray pumps, and a pump of any size, bucket, knapsack, barrel or tank, may be secured easily. There are various methods used in these pumps for applying force, but the thing desired is a steady, even application of it, and any pump which accomplishes this will do good work. There have been found in certain sections so-called gravity sprayers. There is no excuse for the sale of these, as there is scarcely any force given to the application of the treatment, and little good results.

In case that treatment is applied with dry matter, or in powder form, it is quite essential that force should be applied to this also. There are powder guns to be obtained which apply the powder with force and thus secure both thorough application and adherence of the material. A number of powder guns are also to be found on the market and may be secured easily.

Practically, with one exception, all the orchard pests and diseases may be treated through the agency of the spray pump. The exception is the blight of the pear, apple and quince. While spraying may be employed for these, the best treatment is to be found in the knife.

PEAR BLIGHT.

This is probably the worst plant disease known. A great many inquiries come to the Station, asking for treatment for the blight. The treatment itself is very simple. It consists of a careful removal and destruction of the affected part, and a late fall inspection and pruning. This is the best treatment known at the present time. Care should be taken always to keep the knife and saw away from the diseased wood by cutting well below the diseased part, so as not to carry the disease from tree to tree by inoculation. If there is danger of this being done, the knife should be sterilized frequently by washing it in a 1% solution of carbolic acid.

The varieties of sand pears (Pyrus sinensis) which are grown in the South, are very luxuriant growers, especially on our moist alluvial lands, and, this being the case, manures should be applied to them with caution. In the majority of cases opposite treatment should be sought. that is, to seek to control growth, and subdue the luxuriance. This is difficult to do in the alluvial lands, which are moist and fertile, but the very least amount of tillage, at the same time keeping them reasonably clean, will go far toward checking excessive growth.

On the proper soils the problem is not so difficult. It is not meant by this that pears should be neglected. They, like other fruits, repay in proportion to the amount of intelligent attention they receive. When blight appears it should be removed and destroyed at once. Spraying has been followed by a few, but experiments do not show that much can be expected in the way of results. The aim should be to check growth, as young and tender shoots become diseased quickly, and to prune and destroy the affected parts.

There are a number of so-called blight remedies being sold throughout Louisiana, made up of various drugs and materials. Some of these to be used by applying the materials to the roots of the trees, and others to be injected or deposited in the body of the tree. One of these remedies examined some time ago was composed almost entirely of brick dust; others contain calomel, sulphur, etc.

There is no reliable evidence to be obtained that these remedies have ever accomplished anything more than the circulation of money, often hard-earned, which could have been put to a better use.

To repeat, *the best known treatment for the pear blight, and other similar blights, is to carefully cut it out and destroy it.*

TREATMENT FOR EATING INSECTS.

As a rule any insect that eats any outside portion of the plant may be treated very easily. It should be fed some material not hurtful to the plant, but poisonous to the insect. There are two standard materials, among the many poisons, that may be mentioned as leaders. These are Paris Green and Arsenate of Lead. These are sometimes called stomach poisons.

Paris Green.—This old remedy has been used for many years. Chemically it is aceto-arsenite of copper and is practically insoluble in water and not absorbed by vegetable tissue unless it contains an unusually large amount of soluble arsenious acid. When applied pure, as many cotton planters practice, it is often very injurious to plants. It may be used either wet or dry.

Formula, Paris Green, Wet.—

Paris Green........	1 pound
Quick lime.........	2 pounds
Water...	200 gallons

Slake the lime and add the Paris Green gradually. Then add water to the required amount. The lime may be omitted, but it lessens the danger of injuring the foliage. Amount of water should be increased for tender foliage, such as the peach and other stone fruits.

Formula, Paris Green, Dry.—

Paris Green............................	1 pound
Flour, gypsum, or air-slaked lime.........	50 to 100 pounds

Mix thoroughly and apply with a powder gun early in the morning when dew is on. Parish Green sold in Louisiana, by law, should have a tag showing that it has been analyzed and is up to the standard.

Arsenate of Lead.—This arsenic compound has recently come into use and is very rapidly taking the place of Parish Green in garden and orchard treatment. From one to three pounds of Arsenate of Lead is used with fifty gallons of water. The mixture may be made very easily by weighing out the required amount of Arsenate of Lead, and adding a small quantity of water. Stir this into a paste, add more water, making it a thick mixture and then pour it into the full quantity of water, and thoroughly stir. It is easy to make, does not injure foliage, and is cheap and efficient.

TREATMENT FOR SUCKING INSECTS.

There are a large number of pests that do not devour a plant, but instead suck the juices and endanger its life. In the orchard will be found the plant lice and scales which belong to this class. As it is impossible to feed them poison, it is necessary to apply some substance that will kill by contact. Various substances have been used for this purpose. For the plant lice or aphis the standard treatment is whale oil soap or coal oil emulsion, either of which is effectual. These are known as contact poisons.

Coal Oil Emulsion.—There are a number of different methods of making this mixture, but the following one will be found satisfactory:

Boiling rain water	1 gallon
Hard soap	1-2 pound
dissolve by boiling, remove from the fire and add	
Coal oil	2 gallons

Churn this mixture for twenty minutes. This may be done easily by running the mixture through the spray pump. For plant lice use one part of this mixture to fifteen parts of water. For other insects use one part to ten parts of water. Thorough agitation of the material before using is necessary. This is a very cheap and effectual remedy, very easily applied with a sprayer.

Whale Oil Soap.—This is a simple suds made by using one pound of whale oil soap to five to seven gallons of water. Increase the water for the more tender plants. Churn into a thorough suds so as to make a most thorough solution before using. This is a very simple and effectual remedy also, easily made and sprays with no difficulty.

SCALES.

By far the worst pests of the orchard at the present time are the different scale insects, which by their persistent attacks and overwhelming numbers suck the juices of the fruit trees. As they cover themselves with a protective coating or scale, they have to be treated by using a very powerful and penetrating solution. The worst one of these scales is common now over most of the United States and we have it in nearly all sections of Louisiana. It is the San Jose scale. Treatment for this scale will be effectual for others as well, unless the tree be an evergreen, in which case some mixture not hurtful to green foliage must be used.

The Lime-Sulphur Solution.—This solution is the standard treatment for the San Jose scale, and is made as follows:

Formula.

Stone lime	21 pounds
Sulphur	18 pounds
Water	50 gallons

Have plenty of hot water on hand and if possible use a 50-gallon iron kettle for making the mixture. In the kettle heat up a few gallons of water. When brought to a boil, add the sulphur which should be previously mixed with cold water and made into a paste. This will facilitate mixing later on. After the sulphur is added, stir it thoroughly and then add the stone lime. Violent boiling will then take place, which helps to break down the sulphur and causes it to combine with the lime. From time to time add water and continue the boiling for forty minutes. When complete there should be fifty gallons of the mixture, and it should be used when hot.

This mixture is for winter use on dominant deciduous trees only, and is the best treatment known for this serious pest.

Resin Wash.—There are certain pests upon evergreen trees, like the orange, which require a stronger wash than either the coal oil emulsion or whale oil soap. While the latter mentioned remedies are servicable in summer time a winter treatment of the resin wash is much more beneficial. The white fly upon the orange will require such treatment. It is made as follows:

Formula.

Resin	20 pounds
Caustic Soda 98%	4 1-4 pounds
Fish oil	3 pints

Water for final amount 150 gallons.

In a large kettle heat 14 gallons of water and when heated add the resin and the fish oil, after which add the soda in small quantities to prevent sudden violent boiling. Boil for two or three hours, and add warm water occasionally to prevent boiling over. Cold water for this purpose should not be used. This material when completed will be sufficient for a total of 150 gallons. When strained it will be ready for use. It is essentially a smothering mixture for evergreen trees in their most dormant season. For summer treatment of these trees the common whale oil soap is used.

BORERS.

The borers which infest many of the fruit trees are very difficult to control. Being insects which live inside the tree or the fruit, they are safe from anything that can be done after they once get in. The remedies are mainly preventive.

There are a number of things to do for the tree borers, which are so bad upon the peach trees. White wash has been used with beneficial results, also various dressings of materials that will be obnoxious to the insect, which usually contain some coal tar preparation. There are, however, serious objections to coal tar, as it may contain many impurities, which may be very injurious to the tree.

Banking up the tree with earth in summer and removing it late in the fall is also practiced. This causes the moth to lay its eggs, which is done generally in August above the bank of earth. When this is done in the North, the cold weather often injures the larvae. It is doubtful if the cold weather in Louisiana ever affects the insect. When the larvae penetrate the bark of the tree above the bank of earth it may be detected more easily.

Various materials have also been used for wrapping the tree, with more or less success, but after all the only reliable method is to personally examine each tree and remove every borer. This should be done in October and November most thoroughly. A good knife and a pointed wire are all that is necessary for the work and each mass of gum and "chips" examined, removed, and the channel left by the borer followed, and the pest killed. This is expensive treatment, but it is effectual. A heavy coat of whitewash after "worming" will make it objectionable to the borers that follow.

CURCURLIO.

These are fruit borers that infest the young fruit of the plum and the peach. Spraying with Paris Green or Arsenate of Lead is practiced, just as the blossoms fall, and repeated once or twice at intervals of ten days. The jarring process is also followed. This consists of using a canvass sheet under the tree, and jarring the tree. The curcurlio feigns death when disturbed and falls on the canvas sheet and is collected. The best time for this is very early in the morning. Inverted umbrella-shaped canvas-covered frames, placed on wheels so as to be easily placed under the tree, are used in the Northern plum orchards, and it is stated that 75 per cent of the curculios are thus collected. Chickens running in the peach and plum orchard are very useful in picking up the beetles, while pigs if allowed at intervals in the orchard destroy many of the curcurlios by eating the fallen fruit.

COMBINED TREATMENT.

Sometimes it happens that an insecticide and a fungicide are both needed. In that case some of them may be combined.

To Bordeaux Mixture, consisting of 50 gallons, add 6 ounces of Paris Green, or 1 1-2 pounds of Arsenate of Lead. This will serve both purposes.

ROOT GALL AND ROOT KNOT.

These troubles, though distinct, are both to be treated in the same manner. The Root Gall or Crown Gall, as it is often called, appears near the crown of the roots, while the Root Knot appears on the smaller roots. Usually these troubles come to the orchard through the young trees obtained from a nursery that has them. It is well then to examine every young tree purchased, and not plant any that has galls, knots or swellings anywhere upon its roots. Treatment consists of digging up and destroying all affected trees, and not to deal with nurserymen who sell trees having galls or knots upon the rootlets of the young trees in his nursery.

TREATMENT FOR FUNGOUS DISEASES.

There are numerous fungous diseases which attack the orchard tree. Among them will be found the mildews, moulds, rusts, leaf diseases, fruit rots and sundry other diseases. These diseases are propagated by means of spores that are carried by insects and the wind from plant to plant. When they rest upon a plant, and conditions become favorable for growth, these spores germinate, grow and live either *on* or *in* the tissues of the plant, as the case may be, and the plant becomes diseased.

Years ago it was found that the presence of copper in the most minute quantity prevented spore germination and also checked the growth of fungous diseases, and treatment today consists in applications which contain copper in some form. Sulphur is also used.

The two standard remedies for all these fungous diseases are Bordeaux Mixture and Ammoniacal Carbonate of Copper.

BORDEAUX MIXTURE.

This is made as follows:

Formula.

Sulphate of copper..................	4 pounds
Quick lime (air slaked, 10 pounds)....	6 pounds
Water to make.......................	50 gallons

Dissolve the sulphate of copper in five gallons of water, using a wooden vessel. A barrel will answer. In another vessel slake the lime in a small quantity of water. When cooled, pour the lime solution into the copper solution, mixing thoroughly by constant stirring. After mixing, dilute to the required quantity.

This is a standard mixture, universally used on all fungous diseases. It is readily seen, which adds value to it under certain conditions.

AMMONIACAL CARBONATE OF COPPER.

This remedy is quite easily made, and when put upon plants can scarcely be seen. It is very effectual and easier to spray than the Bordeaux Mixture.

Formula.

Carbonate of copper.................	5 ounces
Ammonia, enough to dissolve it, about.	3 pints
Water......	50 gallons

Wet the carbonate of copper before pouring it into the ammonia and use an open dish, as chemical action may be vigorous. Where the Bordeaux Mixture would be unsightly or not desired, this solution answers the purpose just as well.

It should be remembered that solutions of copper act upon ordinary metal vessels and should always be handled in wooden, glass, brass or copper receptacles.

COST OF VARIOUS INGREDIENTS USED IN FIGHTING ORCHARD PESTS

AND DISEASES.

Sulphate of copper	about	8c per pound
Carbonate of copper	“	25c per pound
Ammonia	“	$1.50 per gallon
Paris green	“	30c per pound
Arsenate of lead	“	18c per pound
Sulphur	“	4c per pound
Stone lime	“	25-40c per bu.
Whale oil	“	15c per pound

The following firms make or handle spraying machinery:

Goulds Manufacturing Co., Seneca Falls, N. Y.
The Deming Co., Salem, Ohio.
Field Force Pump Co., Elmira, N. Y.
Morrill & Morley, Benton Harbor, Mich.
F. E. Myers Pump Co., Ashland, Ohio.
Wm. Stahl, Quincy, Ill.
Spray-Mortor Co., Buffalo, N. Y.
Beck & Gregg Hardware Co., Atlanta, Ga.
P. J. Berckmans Co., Augusta, Ga.
Leggett & Brother, New York, N. Y.

ORCHARD FERTILIZERS.

The problem of fertilizing the orchard is rather a difficult one. The early life of the tree, for two or three or more years, according to the kind, should be devoted to growth. The lands of Louisiana outside of the sandy sections possess so much fertility, especially nitrogen, that growth is too vigorous and luxuriant, and fruit trees are apt to devote their energies to growth and not to fruit production. It is doubtful if nitrogen in any form, even in a crop of cow peas, should ever be applied to fruit trees in the rich lands of Louisiana.

In the hill lands and pine flats the case is different and in their early growth the trees should be fertilized with some good general mixture, similar to that used for cotton or corn. When the orchard comes into fruitage, its function is not to grow, but to produce fruit and seed. Its demands consequently are for those manurial elements which are needful for production of fruit.

Nitrogen should not be used at this time, then, unless the general behavior of the tree indicates a need of it. Phosphoric acid and potash, however, constitute the great orchard manurial elements, needful for the production of fruit, and the following ingredients are recommended:

100 lbs. ground bone.
100 lbs. acid phosphate.
100 lbs. muriate of potash.

No nitrogen should be added to this unless the general condition of the trees should indicate a need of it, and, should that occur, a crop of cow peas turned under would probably supply all that would be needed.

Three hundred pounds of the mixture given, per acre, would not be a heavy dressing. Some orchardists increase this amount, as the orchard grows older and increases its yield of fruit, to 1000 pounds per acre. The character of the land, and the behavior of the tree, would govern largely the kind and amount of manure used, and one has to observe these things closely in order to intelligently manage the problem of fertilization.

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Agricultural Experiment Station

OF THE

Louisiana State University
and A. & M. College,

BATON ROUGE.

ANALYSES
OF
COMMERCIAL FERTILIZERS
AND
PARIS GREEN.

J. E. HALLIGAN, B. S.

BATON ROUGE, LA.
DAILY STATE PUBLISHING CO.
1908.

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Fertilizers and Paris Green.

SUMMARY OF RESULTS OF ANALYSES OF FERTILIZERS AND PARIS GREEN MADE IN THE CHEMICAL LABORATORY OF THE STATE EXPERIMENT STATION OF THE LOUISIANA STATE UNIVERSITY AND A. & M. COLLEGE, BATON ROUGE, LOUISIANA, FOR THE YEAR 1907-1908.

BY J. E. HALLIGAN.*

Complete fertilizers	2,665
Fertilizers containing phosphoric acid and nitrogen, not tankages	192
Fertilizers containing phosphoric acid and potash	214
Acid phosphates	597
Bone meals	288
Tankages	357
Cotton seed meals	764
Chemicals	123
Miscellaneous	67
Paris green	40
Total analyses	5,307

COMPLETE FERTILIZERS.

A complete fertilizer is one that contains the three essential elements: nitrogen, phosphoric acid, and potash.

CLASSIFICATION.

Number of Samples Analyzed.	No. of Samples		Below the Guarantee in Available Phosphoric Acid and Nitrogen	Below the Guarantee in Available Phosphoric Acid and Potash	Below the Guarantee in Nitrogen and Potash	Below the Guarantee in Available Phosphoric Acid only	Below the Guarantee in Nitrogen only	Below the Guarantee in Potash only
	Equal to or above the Guarantee in All Three Elements	Below the Guarantee in One or More Elements						
2,665	1,620	1,045	46	16	68	264	503	148

---

*With the assistance of W. G. Taggart, B. S., A. P. Kerr, B. S., and Rene Baus, B. S.

W. D. Morgan, B. S. and S. W. Pipes, B. S., performed clerical work in reporting the samples.

The above classification shows there is a tendency for this class of fertilizers to be deficient in the most valuable element, namely: nitrogen. There were more samples which ran above their guarantee in potash than in any other element. When the nitrogen is below the guarantee, there is generally an excess of one or both of the other elements present. There were not any shipments that fell below the guarantee in all three elements.

AVERAGE ANALYSES.

Total Number of		Average per cent of Available Phosphoric Acid		Average per cent of Nitrogen		Average per cent of Potash	
Samples	Brands	Found	Guaranteed	Found	Guaranteed	Found	Guaranteed
2,665	117	9.51	8.66	2.05	2.07	2.55	2.16

FERTILIZERS CONTAINING NITROGEN AND PHOSPHORIC ACID, NOT TANKAGE.

These fertilizers are used to a great extent on the sugar plantations. When there is a deficiency in this class of material, it is generally in the nitrogen content.

CLASSIFICATION.

Number of Samples Analyzed	No. of Samples		Below the Guarantee in Available Phosphoric Acid and Nitrogen	Below the Guarantee in Available Phosphoric Acid only	Below the Guarantee in Nitrogen only
	Equal to or above the Guarantee in Both Elements	Below the Guarantee in One or Both Elements			
192	98	94	4	26	64

AVERAGE ANALYSES.

Total Number of		Average per cent of Available Phosphoric Acid		Average per cent. of Nitrogen	
Samples	Brands	Found	Guaranteed	Found	Guaranteed
192	5	8.14	6.92	4.59	4.52

FERTILIZERS CONTAINING PHOSPHORIC ACID AND POTASH.

The fertilizers under this head are made up of acid phosphate and potash, and dissolved bone and potash.

CLASSIFICATION.

Number of Samples Analyzed	No. of Samples		Below the Guarantee in Available Phosphoric Acid and Potash	Below the Guarantee in Available Phosphoric Acid only	Below the Guarantee in Potash only
	Equal to or above the Guarantee in Both Elements	Below the Guarantee in One or Both Elements			
214	119	95	3	17	75

AVERAGE ANALYSES.

Total Number of		Average per cent of Available Phosphoric Acid		Average per cent of Potash	
Samples	Brands	Found	Guaranteed	Found	Guaranteed
214	21	11.39	10.57	2.95	2.60

ACID PHOSPHATES AND SUPERPHOSPHATES.

This class of fertilizers contains one valuable element, namely: phosphorous.

These fertilizers are prepared by treating bone ash, bone black and phosphatic rocks with sulphuric acid to render the phosphoric acid available.

CLASSIFICATION AND AVERAGE ANALYSES.

Number of Samples Analyzed	Number of Samples		Total Number of Brands	Average per cent of Available Phosphoric Acid	
	Equal to or above the Guarantee	Below the Guarantee		Found	Guaranteed
597	482	115	40	14.86	14.33

BONE MEALS.

These fertilizers contain nitrogen and phosphoric acid and they should be purchased on the mechanical condition as well as on the guarantee. The finer the bone the more readily is it available. The phosphoric acid in bone meal is practically all insoluble and very little of it is immediately available.

CLASSIFICATION.

Number of Samples Analyzed	Number of Samples		Below the Guarantee in Total Phosphoric Acid and Nitrogen	Below the Guarantee in Total Phosphoric Acid only	Below the Guarantee in Nitrogen only
	Equal to or above the Guarantee in Both Elements	Below the Guarantee in One or Both Elements			
288	269	19	5	2	12

AVERAGE ANALYSES.

Total Number of		Average per cent of Total Phosphoric Acid		Average per cent of Nitrogen	
Samples	Brands	Found	Guaranteed	Found	Guaranteed
288	8	25.38	23.02	2.87	2.61

TANKAGE.

Tankage is composed entirely of animal matter. It is the refuse from slaughter houses and consists of meat, bone, etc. (from which the fat has been extracted), and more or less dried blood.

The phosphoric acid in tankage is slowly available, as it is supplied principally by ground bone. The ammonia is derived principally from meat and blood. When the percentage of bone is large, the phosphoric acid is high, and the ammonia content is low, and when there is an excess of blood and meat, the ammonia is high and the phosphoric acid low.

All tankages are analyzed separately and given immediate attention on their receipt at this laboratory, as settlement between the purchaser and seller is frequently made on the result of our analyses.

The tankage put out by the Planters' Fertilizer Company was guaranteed in nitrogen only, but the phosphoric acid content was sought and only a trace was found.

CLASSIFICATION.

Number of Samples Analyzed	Number of Samples		Below the Guarantee in Total Phosphoric Acid and Nitrogen	Below the Guarantee in Total Phosphoric Acid only	Below the Guarantee in Nitrogen only
	Equal to or above the Guarantee in Both Elements	Below the Guarantee in One or Both Elements			
357	190	167	4	12	151

AVERAGE ANALYSES.

Total Number of		Average per cent of Total Phosphoric		Average per cent of Nitrogen	
Samples	Brands	Found	Guaranteed	Found	Guaranteed
357	33	6.29	4.43	7.43	7.42

COTTON SEED MEAL.

The Inter-State Cotton Seed Crushers' Association, at its meeting in Louisville, Ky., May 19-21, 1908, adopted the following as a standard classification for cotton seed meal:

Choice Cotton Seed Meal must contain by analysis 8 per cent ammonia (which is equivalent to 6.58 per cent nitrogen).

Prime Cotton Seed Meal must contain by analysis 7.50 ammonia (which is equivalent to 6.17 per cent nitrogen).

Good Cotton Seed Meal must contain by analysis 7.00 ammonia (which is equivalent to 5.76 per cent nitrogen).

Some planters seem to purchase cotton seed meal regardless of the guarantee. We receive many communications from farmers complaining about their cotton seed meal. The following letter is a typical example:

"I am sending you a sample of stuff that our oil mill is selling to the farmers in this section for cotton seed meal. It plugs up our distributors and since I have put it on my land I have received poor results. What shall I do?"

On receiving the sample we found that the meal was full of lint and hulls, but the tag showed a guarantee of only 4 per cent nitrogen. The meal ran above the guarantee. We wrote and told this planter that the meal was better than the oil mill claimed it to be and nothing further could be done. We advised him to consult the guarantee before making any further purchases.

There are some farmers who seem to think that nitrate of soda, sulphate of ammonia, tankage or some other nitrogenous material is sometimes added to low grade meal to increase its nitrogen content. Nitrogen in any fertilizing material that would raise the nitrogen content of meal costs too much to use it in this way. An examination of several meals has never shown any fortifying material present.

A physical examination of cotton seed meal will not always show its fertilizing value. Many of the meals have the hulls so finely ground that it is impossible to detect the extent of their presence with the naked eye. The color of a meal is not always an indication of its nitrogen content. Avoid meal which contains a great deal of lint and hulls. Our law requires all meal to be guaranteed and before purchasing, demand this guarantee and buy accordingly.

CLASSIFICATION AND AVERAGE ANALYSES.

Number of Samples Analyzed	Number of Samples		Number of Brands	Average per cent of Nitrogen	
	Equal to or above the Guarantee	Below the Guarantee		Found	Guaranteed
764	530	234	80	6.52	6.20

NITRATE OF SODA.

Nitrate of soda, sometimes called "Chili Saltpetre," is obtained from vast deposits on the west coast of Chili. On account of its solubility, great care must be exercised in its application.

CLASSIFICATION AND AVERAGE ANALYSES.

Number of Samples Analyzed	Number of Samples		Number of Brands	Average per cent of Nitrogen	
	Equal to or above the Guarantee	Below the Guarantee		Found	Guaranteed
34	27	7	7	15.22	15.09

POTASH MINERALS.

Kainit, Muriate of Potash and Sulphate of Potash are the potash minerals that we received samples of this year, and most of them were of excellent quality. These minerals are derived from the Stassfurt mines of Germany.

Kainit is the crude product of the mines, while muriate and sulphate of potash are the manufactured products.

Most all of the potash in kainit is in the form of sulphate, although its association with sodium chloride and magnesium chloride causes it to have a similar effect to muriate of potash.

On account of the sodium chloride present in muriate of potash, large amounts of this mineral are sometimes injurious to potatoes and tobacco. Sulphate of potash is the best form of potash for tobacco and potatoes. Kainit, muriate of potash and sulphate of potash are soluble in water and care should be used when applying them.

One kainit failed to meet its guarantee. All other potash minerals equalled or ran above the guarantee. This is indeed an excellent showing.

CLASSIFICATION AND AVERAGE ANALYSES.

Name of Mineral	Number of Samples	Number below the Guarantee	Number of Brands	Average per cent of Potash	
				Found	Guaranteed
Kainit..............	58	1	12	13.81	12.00
Muriate of potash....	22	0	6	53.71	48.17
Sulphate of potash....	9	0	3	50.32	47.17

GENERAL REMARKS.

As a whole, the fertilizers sold in Louisiana the past season have been up to the manufacturers' claims and of good quality. Some of the fertilizers show poor mechanical mixture, and two samples of the same brand taken from the same shipment sometimes give a variation in the results. It is hard for the manufacturers to secure absolute even mixtures, but in some shipments lumps of raw material were found that could have been avoided by careful manufacture. There were many shipments which fell below the guarantee in one element, but this was due to poor mechanical mixture, and it was not intentional on the part of the manufacturers. In most cases the commercial value exceeded the guaranteed value.

PURCHASE FERTILIZERS ON THE GUARANTEE.

There are some agents who sell fertilizers at high prices regardless of its composition. One agent says, "Give me the lowest priced fertilizer you have, for I can get as much for it as for high grade goods." The above statement was made to one of our large manufacturers, and it shows the necessity for all purchasers of fertilizers to be on their guard and buy on a strict guarantee.

DETERIORATION OF FERTILIZERS.

An examination of some fertilizers sent in by planters who had kept them in dry storage for over a year showed that there was practically no change in the composition from that obtained the year previous.

When fertilizers get damp or wet, in all probability they will decrease in value; but when they are stored in a dry place and kept dry there will be hardly any deterioration.

SUMMARY FOR THREE YEARS.

The following table offers a comparison of the work done at this laboratory for the past three years:

	1905-6	1906-7	1907-8
Complete fertilizers	1,302	2,164	2,665
Fertilizers containing phosphoric acid and nitrogen, not tankages	40	67	192
Fertilizers containing phosphoric acid and potash	54	95	214
Acid phosphates	199	486	597
Bone meals	123	206	288
Tankages	372	206	357
Cotton seed meals	328	864	764
Chemicals	38	58	123
Miscellaneous	52	15	67
Paris green	73	214	40
Total number of samples	2,581	4,375	5,307

RECIPES.

In the early part of this past season this laboratory received inquiries concerning fertilizer recipes that were being sold to our farmers. Below is a copy of one of these recipes:

FARM RIGHT.

$5.00.

WALLIS' COMPLETE GUIDE FOR COMPOUNDING FERTILIZERS.

Take Saltpeter, 2 pounds; Bluestone, 2 pounds; Soda Ash, 4 pounds; Nitrate Ammonia, 2 pounds; Potash, 4 pounds. Dissolve the whole in six gallons of water; put 100 pounds of stable manure in a pen and sprinkle it with a portion of the solution. Then take 50 pounds of unslacked ashes, 5 pounds of salt and 5 pounds of lime; sprinkle these on the manure, continuing the process until the ton is completed, and let it remain in a dry place for 30 days. Use from 200 to 400 pounds per acre and bed it on the other fertilizers.

We prefer the form thus presented, but it may be variously modified without departing from the principle of our invention, so long as the same steps are taken in the manner of preparing. For example: When prepared for corn the lime and ashes may be omitted and fifty pounds more of the salt and two pounds more of the soda ash added to the ton. Second: If a lower grade of fertilizer is desired, use less of the ingredients; if a higher grade is wanted, use more. Third: Cotton seed makes a most desirable base for the fertilizer.

NOTE—For lime lands add salt instead of lime. Any rich soil or muck will answer instead of stable manure. When earth is used always use lime and ashes. To use as Guano, put in sand instead of stable manure, and add fifty pounds more of lime to the ton, add six pounds more of ammonia and fifty pounds more of salt. For land that is infested with bugs and worms that destroy the young plants, put in ten pounds more of bluestone to the ton. Use 200 to 400 pounds to the acre and bed on it as other fertilizers. The compound destroys all bugs and insects.

Any person using this formula without authority will be liable to a fine and imprisonment under the United States laws, and any person using same without authority will be prosecuted to the full extent of the law.

Entered in the Patent Office, June 11, 1892.

Serial No. 436,386.

WALLIS & ROACH.

The above recipe is practically worthless and anybody who pays $5.00 for such a fraud gives away his hard-earned money. The bluestone and soda ash have no fertilizing value and the amount of fertilizing material present in saltpetre, nitrate of ammonia and potash can be purchased on our market for 50 cents, or less. The stable manure and the cotton seed meal mentioned in the above circular are of course good fertilizers, but the addition of lime and potash to these materials would act upon the ammonia present and drive it off.

The potash present in the above formula would drive off the ammonia in the nitrate of ammonia.

Prof. Newell, Chief Entomologist of the Experiment Station, says: "Bluestone in the amount mentioned in the above recipe would render conditions more favorable for the ordinary insects which are injurious to farm crops."

Any farmer following the directions as laid down in the above circular is bound to be disappointed with the results obtained. This laboratory is at all times glad to help farmers in fertilizing problems, *free of charge,* and it is an injustice to the honest manufacturers doing business in this State to waste time and money with fertilizer recipes.

REBATES.

This office receives many inquiries concerning rebates on fertilizers. Below is the style of letter received:

"Give me the rebate on twenty tons of the Smith Fertilizer Co.'s Cotton Fertilizer, chemist report number 4060. This fertilizer did not reach the guarantee as per my contract and a much larger quantity had to be used to obtain the same results as guaranteed by them. I paid $28.00 a ton for this fertilizer."

This shipment of fertilizer was guaranteed as follows:

Available phosphoric acid	10.00	per cent
Nitrogen	1.65	
Potash	2.00	

We found by analysis the following percentages:

Available phosphoric acid	10.20	per cent
Nitrogen	1.32	
Potash	2.31	

From the ruling wholesale values for the season, potash is taken as 1.00, nitrogen as 4.00 and available phosphoric acid as 1.3375. Then, if we multiply the percentages of available phosphoric acid, nitrogen and potash as guaranteed by their respective units we get the total units guaranteed. Example:

Available phosphoric acid	10.00 x 1.3375	=13.375
Nitrogen	1.65 x 4	= 6.60
Potash	2.00 x 1	= 2.00
Total units guaranteed		=21.975

In a similar manner the total units as found by analysis are figured. Example:

Available phosphoric acid.....	10.20 x 1.3375	=13.6425
Nitrogen....	1.32 x 4	= 5.28
Potash	2.31 x 1	= 2.31
Total units found by analysis..		=21.2325

Then the units guaranteed are, to the units found, as the contract price paid per ton, is to the actual price that should be paid per ton. Or,

21.975 : 21.2325 = 28 : X   21.975 X = 21.2325 x 28
21.975 X = 594.51   X = $27.05, or the actual
price that should be paid per ton.

Now $28 (the contract price per ton) minus $27.05 (the actual price that should be paid per ton) equals $0.95, or the rebate per ton. There were twenty tons purchased; then, 20×$0.95=$19.00, the total rebate on twenty tons.

The rebate on cotton seed meal is arrived at in the following manner. Example: The meal is sold at $25.00 per ton and guaranteed to contain 6.59 per cent of nitrogen. An examination of this meal shows 6.30 per cent of nitrogen.

Then 6.59 (the per cent of nitrogen guaranteed) is to 6.30 (the per cent of nitrogen found), as $25 (the contract price per ton) is to (the actual price that should be paid per ton).

That is, 6.59 : 6.30 = 25 : X   6.59 X = 157.50

X = $23.90, or the actual price that should be paid per ton

Then $25 (the contract price per ton) minus $23.90 (the actual price that should be paid per ton) equals $1.10, or the rebate per ton.

These figures are not the same as those adopted by the Inter-State Cotton Seed Crushers' Association for fixing rebates, as we figure on the actual nitrogen content as guaranteed and found.

The phosphoric acid and potash contents are not considered in figuring the above rebate, as the planters, in purchasing cotton seed meal for fertilizing purposes, contract only for the percentage of nitrogen. The phosphoric acid and potash in cotton seed meal are less variable than the nitrogen.

The rebate on acid phosphate is figured as follows:

An acid phosphate guaranteed 14 per cent available phosphoric acid analyzes 13.23 per cent available phosphoric acid. Contract price per ton, $16.00.

Then 14 (the per cent of available phosphoric acid guaranteed) is to 13.23 (the per cent of available phosphoric acid found) as 16 (the contract price per ton) is to (the actual price that should be paid per ton). Or,

$14 : 13.23 = 16 : X \quad 14X = 13.23 \times 16$

$14X = 211.68 \quad X =$ $15.12, or the actual price that should be paid per ton.

Then $16.00 (the contract price per ton) minus $15.12 (the actual price that should be paid per ton) equals $0.88, the rebate per ton.

The rebates on other fertilizers are obtained in the same way as explained in the above examples, unless some other style of contract is agreed upon by the purchaser and the manufacturer or dealer or agent.

FOREIGN IMPORTED TANKAGE.

There was a company who put out a fertilizer under the name of Foreign Imported Tankage, which was imported from some foreign country. An examination of this material showed the presence of wool waste, shoddy, hair and leather. Out of a total nitrogen content of 7.19 per cent, 3.50 per cent was found available. The purchaser and the manufacturer were acquainted with our findings, and we notified both parties that nitrogen derived from this leather was not suitable for plant food on account of its unavailability. We also told them that hair, wool, waste and shoddy were objectionable sources of nitrogen, and we feel that such material should not be offered for sale in this State.

After a great deal of controversy between the purchaser, manufacturer and this office, the matter was adjusted by allowing the purchaser a much reduced price for the fertilizer.

Some of our planters are not aware of the unsuitableness of such material for fertilizing purposes, and we deem it our duty to inform them when we find adulterants such as leather used in our commercial fertilizers.

This material was also used in making some of this company's Raw Bone Superphosphate. Out of sixty samples analyzed, forty-one samples were found with leather present. The purchasers of these shipments were notified that the nitrogen furnished by the leather was practically unavailable as a plant food. Of course the phosphoric acid and potash contents were not affected.

The above case shows the necessity for our fertilizer law.

In the future any manufacturers putting out such adulterated fertilizer as mentioned in the above article will have their names published for the protection of purchasers in this State.

MARKET VALUE OF FERTILIZER INGREDIENTS.

The quotations cited in the following table are on the principal raw materials used in the manufacture of commercial fertilizers. These quotations are f. o. b. New Orleans:

	Per 2,000 lbs.
Acid Phosphate, 14 per cent available	$15.00
Tennessee Phosphate Rock, 72%-75% bone phosphate of lime	7.43
Muriate of Potash	39.00
Sulphate of Potash	42.50
Sulphate of Ammonia	61.00
Raw Bone Meal	27.00
Cotton Seed Meal	25.00
German Kainit, 12% Potash (delivered Atlantic ports)	8.25
Nitrate of Soda (delivered Atlantic ports)	46.00

Pyrites, 12½ cents per unit of sulphur.

Dried Blood, $2.65 to $2.70 per unit of ammonia.

Tankage, $2.65 to $2.70 per unit of ammonia; 10 cents per unit of bone phosphate of lime.

The prices quoted on dried blood and tankage are those given by Swift & Co., f. o. b. New Orleans. The values of cotton seed meal were taken from the ruling prices for the year. All other values were obtained from the Standard Guano & Chemical Company of New Orleans, La.

The above prices on the raw materials used in making fertilizers are not constant, as the prices on these materials vary from time to time. However, these values are practically the average prevailing prices for the past season.

VALUATION OF FERTILIZERS.

From the above quotations, we arrive at the following trade values which are employed in calculating the comparative prices per ton, of 2,000 pounds, as given in this bulletin:

In tankage the phosphoric acid is valued at 21 8 cents per unit, and the ammonia at $2.70 per unit.

The phosphoric acid in bone meal is valued at 80 cents per unit and the nitrogen at $3.60 per unit.

Cotton seed meals are valued by multiplying the nitrogen content by $3.20, which is taken as the unit value for nitrogen; $3.40 is added to this result to cover the value of the phosphoric acid and the potash present in cotton seed meal.

In all other fertilizers the following values are used:

Available phosphoric acid	$1.07 per unit
Potash	.80
Nitrogen	3.20

A unit is equal to 20 pounds, or 1 per cent of a ton.

A fertilizer guaranteed 10 per cent available phosphoric acid, 1.50 per cent potash, and 2.47 per cent nitrogen is worth, according to these values, $19.17 per ton, since:

10.00 per cent available phosphoric acid at $1.07 per unit equals	$10.07
1.50 per cent potash at $0.80 per unit equals	1.20
2.47 per cent nitrogen at 3.20 per unit equals	7.90
Ton value (2,000 pounds)	$19.17

The prices given in this bulletin represent the wholesale cost of fertilizers, and they are given so as to enable the purchaser to arrive at some conclusion concerning the value of his fertilizer. These prices also furnish a basis for comparing the several fertilizers found on our market. The freight, cost of mixing, cost of inspection, cost of sacks, storage, dealers' profit, and manufacturers' profit are not considered.

The market value of a fertilizer should not be taken as its agricultural value in all cases. The market value gives the cost of a fertilizer, while the agricultural value shows the worth of a fertilizer for producing crops. Fertilizers should be selected according to the needs and physical condition of the soil, the fertilizer requirements of the crop, and the composition of the fertilizer as set forth by the guarantee.

PARIS GREEN.

The past season forty samples of Paris Green were received and analyzed and all of them ran above the guarantee of 50 per cent arsenious oxide as required by our law.

It is a source of satisfaction to know that the Paris Green samples inspected this past year have all been of good quality. These samples varied in arsenious oxide from 55.32 per cent to 56.63, and they average 55.85 per cent.

COMPLETE

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	Phosphoric Acid—Water soluble Found %
Arcadia Cotton Oil Mill & Manufacturing Co., Arcadia, La.			
Corn Fertilizer	2572	1	5.10
	3312	1	5.48
	3636	1	6.90
	4189	1	6.13
Average		4	5.90
Cotton Fertilizer	2569	1	7.38
	3142	1	9.40
	3219	1	9.57
	3652	3	7.98
	4190	1	7.30
Average		7	8.33
Arkansas Fertilizer Co., Little Rock, Ark.			
White Diamond Ammoniated Bone Superphosphate	3154	3	5.13
	3811	1	4.15
Average		4	4.64
White Diamond Nitrated Superphosphate with Potash	3891	1	3.68
White Diamond Special H. G. C. Fertilizer	3887	1	5.70
White Diamond Twentieth Century Fertilizer	3119	7	5.90
	3250	2	5.73
	3703	6	5.73
	3812	1	6.08
	3892	4	5.75
Average		20	5.84

FERTILIZERS.

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
			Available								
Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found %	Guarant'd %		Found %	Guarant'd %	Found	Guarant'd
3.66	0.72	9.48	8.76	8.00	3.43	3.00	4.17	1.00	1.00		
2.86	0.61	8.95	8.34	8.00	2.72	3.00	3.31	2.06	1.00		
3.10	1.20	11.20	10.00	8.00	3.00	3.00	3.64	1.04	1.00		
3.57	1.10	10.80	9.70	8.00	3.06	3.00	3.72	0.72	1.00		
3.30	0.91	10.11	9.20	8.00	3.05	3.00	3.71	1.21	1.00	$20.57	$18.96
4.37	0.90	12.65	11.75	10.00	2.34	1.75	2.84	0.72	0.50		
2.69	1.39	13.48	12.09	10.00	1.84	1.75	2.24	0.50	0.50		
2.86	1.25	13.68	12.43	10.00	1.84	1.75	2.24	0.68	0.50		
2.97	1.63	12.58	10.95	10.00	1.71	1.75	2.08	1.10	0.50		
3.96	1.57	12.83	11.26	10.00	1.88	1.75	2.29	0.50	0.50		
3.37	1.35	13.04	11.70	10.00	1.92	1.75	2.34	0.70	0.50	$19.22	$16.70
3.56	2.16	10.85	8.69	9.50	1.74	1.65	2.12	2.42	2.00		
4.04	3.44	11.63	8.19	9.50	1.68	1.65	2.04	2.22	2.00		
3.80	2.80	11.24	8.44	9.50	1.71	1.65	2.08	2.32	2.00	$16.36	$17.05
2.85	1.87	8.40	6.53	8.00	1.26	2.47	1.53	7.81	4.00	$17.27	$19.66
4.21	1.72	11.63	9.91	10.00	1.78	2.00	2.07	2.62	2.50	$18.40	$19.10
3.35	1.55	10.80	9.25	9.50	1.83	1.65	2.22	2.18	2.00		
3.34	1.56	10.63	9.07	9.50	1.31	1.65	1.59	2.02	2.00		
3.21	1.81	10.75	8.94	9.50	1.41	1.65	1.71	2.30	2 00		
2.96	1.41	10.45	9.04	9.50	1.71	1.65	2.08	2.34	2.00		
2.67	1.61	10.03	8.42	9.50	1.65	1.65	2.01	2.26	2.00		
3.11	1.59	10.53	8.94	9.50	1.58	1.65	1.92	2.22	2.00	$16.40	$17.05

COMPLETE

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	Phosphoric Acid—Water soluble Found %
Caddo Fertilizer Co., Shreveport, La.			
Caddo Corn	2531	1	5.03
	2672	2	4.83
	2774	2	6.13
	2833	2	6.13
	2983	2	4.73
	3058	3	5.08
	3120	4	5.03
	3221	1	4.35
	3325	3	4.58
	3495	4	4.63
	3653	2	3.95
	3736	3	3.88
	4047	2	3.88
	4188	1	3.48
	4317	1	7.25
Average		33	4.86
Caddo Cotton	2427	8	6.55
	2455	2	6.58
	2469	1	6.63
	2524	2	6.90
	2570	1	6.55
	2614	3	7.00
	2633	3	6.63
	2671	3	7.13
	2702	4	6.75
	2789	1	6.23
	2826	3	6.60
	2917	6	7.15
	3000	6	6.23
	3056	6	6.00
	3116	5	6.05
	3182	5	5.45
	3287	7	5.58
	3449	8	5.10
	3576	11	5.80
	3729	6	4.68
	3870	5	5.55
	4054	2	5.43
	4321	1	5.98
Average		94	6.20

FERTILIZERS.

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
			Available								
Reverted Found	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found %	Guarant'd %		Found %	Guarant'd %	Found	Guarant'd
3.34	0.76	9.13	8.37	6.00	3.02	2.90	3.67	1.76	1.00		
2.68	1.07	8.58	7.51	6.00	2.94	2.90	3.57	1.92	1.00		
3.38	0.78	10.29	9.51	6.00	3.32	2.90	4.04	1.98	1.00		
3.86	0.66	10.65	9.97	6.00	3.31	2.90	4.02	2.68	1.00		
3.14	0.68	8.55	7.87	6.00	2.90	2.90	3.52	2.68	1.00		
2.79	1.03	8.90	7.87	6.00	2.95	2.00	3.59	1.96	1.00		
3.40	0.72	9.15	8.43	6.00	3.01	2.90	3.66	1.98	1.00		
2.58	0.62	7.55	6.93	6.00	2.75	2.90	3.34	1.76	1.00		
2.30	0.90	7.78	6.88	6.00	2.89	2.90	3.51	1.88	1.00		
3.10	0.77	8.50	7.73	6.00	2.44	2.90	2.97	1.88	1.00		
3.08	0.55	7.58	7.03	6.00	2.50	2.90	3.04	1.92	1.00		
2.89	0.68	7.45	6.77	6.00	2.83	2.90	3.44	1.70	1.00		
3.29	0.88	8.05	7.17	6.00	2.77	2.90	3.36	1.84	1.00		
2.87	1.00	7.35	6.35	6.00	2.62	2.90	3.18	1.40	1.00		
3.36	0.39	11.00	10.61	6.00	2.81	2.90	3.42	1.12	1.00		
3.07	0.77	8.70	7.93	6.00	2.88	2.90	3.49	1.83	1.00	$19.17	$16.50
3.67	0.98	11.20	10.22	8.00	1.79	2.05	2.18	2.36	1.00		
3.94	0.81	11.33	10.52	8.00	1.79	2.05	2.18	2.18	1.00		
3.09	1.08	10.80	9.72	8.00	2.07	2.05	2.51	1.58	1.00		
3.36	1.67	11.93	10.26	8.00	2.76	2.05	3.35	1.68	1.00		
3.04	1.31	10.90	9.59	8.00	2.35	2.05	2.85	1.64	1.00		
3.28	1.60	11.88	10.28	8.00	2.21	2.05	2.69	1.80	1.00		
3.47	1.35	11.45	10.10	8.00	2.21	2.05	2.69	1.86	1.00		
3.41	1.29	11.83	10.54	8.00	2.18	2.05	2.65	1.70	1.00		
3.23	1.12	11.10	9.98	8.00	3.38	2.05	4.11	2.08	1.00		
3.57	1.05	10.85	9.80	8.00	2.29	2.05	2.78	2.36	1.00		
3.83	0.87	11.30	10.42	8.00	2.16	2.05	2.63	2.64	1.00		
4.15	1.18	12.48	11.30	8.00	2.37	2.05	2.88	1.74	1.00		
3.82	1.10	11.15	10.05	8.00	2.22	2.05	2.70	2.52	1.00		
3.47	1.31	10.78	9.47	8.00	2.06	2.05	2.50	1.58	1.00		
3.72	0.86	10.63	9.77	8.00	1.95	2.05	2.37	1.64	1.00		
2.63	1.07	9.15	8.08	8.00	2.08	2.05	2.53	1.86	1.00		
2.96	1.06	9.60	8.54	8.00	2.13	2.05	2.59	1.68	1.00		
3.09	0.96	9.15	8.19	8.00	2.05	2.05	2.49	1.66	1.00		
3.13	0.95	9.88	8.93	8.00	2.14	2.05	2.60	1.56	1.00		
3.10	0.87	8.65	7.78	8.00	2.43	2.05	2.95	1.66	1.00		
3.20	0.75	9.50	8.75	8.00	2.13	2.05	2.59	1.52	1.00		
3.75	0.95	10.13	9.18	8.00	2.05	2.05	2.49	1.44	1.00		
3.57	1.05	10.60	9.55	8.00	2.05	2.05	2.49	1.36	1.00		
3.41	1.10	10.71	9.61	8.00	2.21	2.05	2.69	1.83	1.00	$18.82	$15.92

COMPLETE

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	Phosphoric Acid—Water soluble Found %
Caddo Fertilizer Co.—Continued.			
Caddo Special	2497	2	5.35
	2560	2	5.15
	2615	1	5.10
	2636	3	5.25
	2677	1	5.05
	2712	1	5.10
	2770	2	4.88
	3049	1	4.83
	3122	2	4.88
	3249	1	4.75
	3359	2	4.45
	3471	1	4.78
	3655	2	5.08
Average		21	4.97
Caddo Vegetable	2453	2	6.95
	2475	1	6.98
	2538	1	7.25
	2676	1	7.00
	2708	2	6.65
	2863	1	6.88
	3061	2	6.18
	3144	1	6.33
	3349	1	6.23
	3559	3	5.28
Average		15	6.57
Caddo Star	2910	1	7.08
	3094	3	6.65
	3230	2	6.68
	3366	2	7.25
	3562	2	7.35
	3702	3	6.45
	3820	1	6.28
	4031	1	6.80
Average		15	6.82

FERTILIZERS.

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
			Available								
Reverted Found ½	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found %	Guarant'd %		Found %	Guarant'd %	Found	Guarant'd
2.44	0.64	8.43	7.79	6.00	1.97	2.50	2.39	7.38	7.00		
2.18	0.97	8.30	7.33	6.00	1.98	2.50	2.41	7.20	7.00		
2.30	0.80	8.20	7.40	6.00	2.00	2.50	2.43	7.02	7.00		
2.71	0.44	8.40	7.96	6.00	2.17	2.50	2.64	6.42	7.00		
2.35	0.70	8.10	7.40	6.00	1.94	2.50	2.36	7.00	7.00		
2.35	0.70	8.15	7.45	6.00	1.98	2.50	2.41	7.02	7.00		
2.32	0.93	8.13	7.20	6.00	2.27	2.50	2.76	5.60	7.00		
2.19	1.13	8.15	7.02	6.00	2.50	2.50	3.04	8.44	7.00		
2.48	0.77	8.13	7.36	6.00	2.81	2.50	3.42	6.74	7.00		
2.13	1.05	7.93	6.88	6.00	2.27	2.50	2.76	7.00	7.00		
2.40	0.80	7.65	6.85	6.00	2.26	2.50	2.75	7.74	7.00		
2.66	1.06	8.50	7.44	6.00	2.50	2.50	3.04	6.60	7.00		
2.37	0.73	8.18	7.45	6.00	2.04	2.50	2.48	5.36	7.00		
2.38	0.82	8.17	7.35	6.00	2.21	2.50	2.68	6.89	7.00	$20.45	$20.02
3.84	0.71	11.50	10.79	8.00	2.14	3.30	2.60	2.44	4.00		
3.95	0.57	11.50	10.93	8.00	2.23	3.30	2.71	3.48	4.00		
3.46	1.22	11.93	10.71	8.00	2.30	3.30	2.80	3.34	4.00		
4.02	0.63	11.65	11.02	8.00	2.37	3.30	2.88	3.60	4.00		
2.61	1.12	10.38	9.26	8.00	3.32	3.30	4.04	3.28	4.00		
3.12	1.28	11.28	10.00	8.00	3.39	3.30	4.12	4.02	4.00		
3.00	0.85	10.03	9.18	8.00	2.98	3.30	3.62	4.48	4.00		
3.00	1.15	10.48	9.33	8.00	2.57	3.30	3.12	4.02	4.00		
3.01	0.94	10.18	9.24	8.00	2.54	3.30	3.09	4.32	4.00		
3.35	1.17	9.80	8.63	8.00	2.32	3.30	2.82	3.62	4.00		
3.34	0.96	10.87	9.91	8.00	2.62	3.30	3.18	3.66	4.00	$21.92	$22.32
4.40	0.62	12.10	11.48	10.00	1.36	1.65	1.65	2.06	1.50		
3.50	1.30	11.45	10.15	10.00	1.89	1.65	2.30	2.00	1.50		
3.59	1.21	11.48	10.27	10.00	1.69	1.65	2.05	1.94	1.50		
3.33	1.35	11.93	10.58	10.00	1.65	1.65	2.01	2.00	1.50		
3.37	1.46	12.18	10.72	10.00	1.65	1.65	2.01	2.88	1.50		
3.10	0.90	10.45	9.55	10.00	1.71	1.65	2.08	1.96	1.50		
3.14	0.88	10.30	9.42	10.00	1.92	1.65	2.33	2.16	1.50		
3.41	1.39	11.60	10.21	10.00	2.14	1.65	2.60	1.52	1.50		
3.48	1.14	11.44	10.30	10.00	1.75	1.65	2.13	2.07	1.50	$18.28	$17.18

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	COMPLETE Phosphoric Acid—Water soluble Found %
Capital Fertilizer and Manufacturing Co., Jackson, Miss.			
Cotton Elevator	2837	1	7.95
Nonpariel	2838	1	8.55
	3038	2	7.25
	3365	3	6.25
	3437	2	6.13
	3762	1	7.13
	4409	2	5.18
Average		11	6.75
Clinton Cotton Oil and Manufacturing Co. Clinton, La.			
Comos Cotton	2581	1	6.55
	2996	2	6.23
	3060	2	6.18
	3444	6	6.55
	3549	1	6.18
	3991	2	6.90
	4271	1	5.75
	4352	2	6.63
Average		17	6.37
Consumers' Fertilizer Co., Shreveport, La.			
Corn	3833	2	3.68
	4029	1	4.90
Average		3	4.29
Cotton	3153	4	7.48
	3356	1	6.78
	3496	4	6.88
	3737	1	6.03
	3831	7	6.28
	4043	2	6.40
Average		19	6.64

FERTILIZERS.

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
			Available								
Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found %	Guarant'd %		Found %	Guarant'd %	Found	Guarant'd
3.25	0.48	11.68	11.20	8.00	3.07	1.65	3.73	2.48	2.00	$23.79	$15.44
2.77	0.46	11.78	11.32	8.00	1.75	1.65	2.13	2.00	2.00		
3.58	0.30	11.13	10.83	8.00	2.47	1.65	3.00	2.00	2.00		
2.26	0.14	8.65	8.51	8.00	1.43	1.65	1.74	2.82	2.00		
3.34	0.13	9.60	9.47	8.00	1.53	1.65	1.86	2.74	2.00		
1.76	0.16	9.05	8.89	8.00	1.67	1.65	2.03	2.12	2.00		
3.18	0.22	8.58	8.36	8.00	1.70	1.65	2.07	2.04	2.00		
2.82	0.24	9.80	9.56	8.00	1.76	1.65	2.14	2.29	2.00	$17.69	$15.44
2.54	1.46	10.55	9.09	8.00	1.75	1.65	2.13	2.54	2.00		
3.04	0.81	10.08	9.27	8.00	2.07	1.65	2.52	2.86	2.00		
2.92	0.73	9.83	9.10	8.00	1.86	1.65	2.26	2.30	2.00		
2.63	1.32	10.50	9.18	8.00	1.80	1.65	2.19	2.18	2.00		
1.95	1.57	9.70	8.13	8.00	1.74	1.65	2.11	2.54	2.00		
2.42	1.41	10.73	9.32	8.00	1.60	1.65	1.94	2.76	2.00		
3.42	1.03	10.20	9.17	8.00	1.46	1.65	1.77	2.00	2.00		
3.51	1.41	11.55	10.14	8.00	1.40	1 65	1.70	1.78	2.00		
2.80	1.22	10.39	9.18	8.00	1.71	1.65	2.08	2.37	2.00	$17.19	$15.44
2.44	0.73	6.85	6.12	6.50	3.10	2.90	3.77	0.72	0.45		
2.34	0.96	8.20	7.24	6.50	3.05	2.90	3.71	0.78	0.45		
2.39	0.85	7.53	6.68	6.50	3.08	2.90	3.74	0.75	0.45	$17.60	$16.60
2.20	1.32	11.00	9.68	9.50	1.89	1.85	2.30	0.54	0.30		
3.01	1.36	11.15	9.79	9 50	2.01	1 85	2.44	0.60	0 30		
2.90	1.15	10.93	9.78	9.50	1.92	1.85	2.33	0.60	0.30		
2.75	1.37	10.15	8.78	9.50	2.02	1.85	2.45	0.56	0.30		
3.14	1.41	10.83	9.42	9.50	1.89	1.85	2.30	0.98	0.30		
3.10	1.00	10.50	9.50	9.50	2.25	1.85	2.73	0.32	0.30		
2.85	1.27	10.76	9.49	9.50	2.00	1.85	2.43	0.60	0.30	$17.03	$16.33

COMPLETE

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	Phosphoric Acid—Water soluble Found %
Consumers' Fertilizer Co.—Continued.			
Special	3808	1	8.65
Tri-State Corn	2783	2	5.10
	3091	1	5.43
	3474	1	4.88
	3852	2	3.93
	4322	1	4.90
Average		7	4.85
Tri-State Cotton	2484	1	9.73
	2798	1	7.53
	2927	2	6.75
	3132	2	8.48
	3322	5	7.25
	3497	3	6.75
	3734	4	5.95
	3834	3	6.50
	4323	1	6.75
Average		22	7.30
Tri-State Special	2681	1	9.13
	2784	2	9.33
	3147	1	8.83
	3357	1	9.93
Average		5	9.31
Federal Chemical Co., Nashville, Tenn. Daybreak Fertilizer	3894	2	7.83
	4057	2	4.53
Average		4	6.18

FERTILIZERS.

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
			Available								
Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found %	Guarant'd %		Found %	Guarant'd %	Found	Guarant'd
2.58	1.42	12.65	11.23	11.00	2.36	2.67	2.87	0.54	0.25	$20.00	$20.51
2.07	1.13	8.30	7.17	6.50	3.19	2.90	3.88	0.98	0.45		
2.16	0.96	8.55	7.59	6.50	2.44	2.90	2.97	2.67	0.45		
2.81	0.91	8.60	7.69	6.50	2.78	2.90	3.38	0.62	0.45		
2.50	1.00	7.43	6.43	6.50	2.98	2 90	3.62	0.80	0.45		
2.73	1.15	8.78	7.63	6.50	2.94	2 90	3.57	0.86	0.45		
2.45	1.03	8.33	7.30	6.50	2.87	2 90	3.48	1.19	0.45	$17.95	$16.60
2.12	1.85	13.70	11.85	9.50	1.85	1.85	2.25	0.50	0.31		
2.54	1.36	11.43	10.07	9.50	2.14	1.85	2.60	0.32	0.31		
3.10	1.45	11.30	9.85	9 50	1.95	1.85	2.37	0.54	0.31		
2.27	1.20	11.95	10.75	9.50	2.05	1.85	2.49	0.74	0.31		
2.53	1.52	11.30	9.78	9.50	1.91	1.85	2.32	0.56	0.31		
2.83	1.22	10.80	9.58	9.50	2.03	1.85	2.46	0.78	0.31		
2.56	1.82	10.33	8.51	9.50	2.15	1.85	2.61	0.52	0 31		
3.10	1.20	10.80	9.60	9.50	1.90	1.85	2.31	0.58	0.31		
3.09	1.31	11.15	9.84	9.50	2.03	1 85	2.46	0.72	0.31		
2.68	1.44	11.42	9.98	.9 50	2.00	1 85	2.43	0.58	0.31	$17.54	$16.33
2.85	1.72	13.70	11.98	11.00	1.78	2.67	2.16	0.34	0.25		
2.80	1.80	13.93	12.13	11.00	2.20	2.67	2.67	0.56	0.25		
2.49	1.28	12.60	11.32	11 00	2.37	2.67	2.88	0.52	0.25		
2.67	0.75	13.35	12.60	11.00	2 67	2 67	3.25	0.66	0.25		
2.70	1.39	13.40	12.01	11 00	2.26	2.67	2.74	0.52	0.25	$20.50	$20.51
3.20	0.72	11.75	11.03	.8 00	1.47	1.65	1.79	1.40	2.00		
3.20	1.15	8.88	7.73	8.00	1.84	1.65	2.24	2.48	2.00		
3.20	0.94	10.32	9.38	8.00	1.66	1.65	2.02	1.94	2.00	$16.90	$15.44

COMPLETE

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	Phosphoric Acid—Water soluble Found %
Gulfport Cotton Oil, Fertilizer and Manufacturing Co., Gulfport, Miss.			
Primo Cotton Seed Meal Mixture.............	2276	4	6.90
	2339	1	7.55
	2799	1	7.28
	4406	1	6.55
Average		7	7.07
Primo High-Grade Blood and Bone...........	2274	5	7.15
	2329	2	7.63
	2565	3	8.45
	2763	3	7.95
	2932	1	7.50
	3324	3	8.28
	3500	4	6.85
	3639	1	8.65
	4128	1	6.18
Average		23	7.63
Primo High-Grade Vegetable Grower	2292	1	5.13
	2936	1	5.40
Average		2	5.27
Primo Standard Cotton and Corn Guano.......	3348	1	6.63
	3893	2	5.50
	4136	1	5.50
Average		4	5.88
Standard Primo Cotton Seed Meal Compound..	2235	1	7.94
	2272	3	7.48
	2342	1	8.05
	2409	1	7.00
	2508	1	8.90
	2571	1	9.50
	2757	3	8.48
	2892	1	6.88
	2979	1	7.08
	3367	5	6.53
	3480	9	6.48
	3890	1	7.13
	3939	1	7.23
	4407	1	6.40
Average		30	7.51

FERTILIZERS.

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
			Available								
Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found %	Guarant'd %		Found %	Guarant'd %	Found	Guarant'd
2.50	0.68	10.08	9.40	10.00	1.75	1.65	2.12	2.72	2.00		
2.50	0.58	10.63	10.05	10.00	2.02	1.65	2.46	2.72	2.00		
2.02	0.70	10.00	9.30	10.00	2.09	1.65	2.54	2.82	2.00		
3.10	1.45	11.10	9.65	10.00	1.73	1.65	2.10	1.60	2.00		
2.53	0.85	10.45	9.60	10.00	1.90	1.65	2.31	2.47	2.00	$18.33	$17.58
2.46	0.87	10.48	9.61	10.00	1.65	1.65	2.00	3.12	2.00		
2.14	0.68	10.45	9.77	10.00	1.76	1.65	2.14	2.40	2.00		
3.03	0.85	12.33	11.48	10.00	1.73	1.65	2.10	2.70	2.00		
2.47	1.06	11.48	10.42	10.00	1.71	1.65	2.08	2.72	2.00		
2.35	0.83	10.68	9.85	10.00	1.80	1.65	2.19	2.90	2.00		
3.15	0.70	12.13	11.43	10.00	1.94	1.65	2.36	2.62	2.00		
2.54	0.71	10.10	9.39	10.00	1.77	1.65	2.15	3.32	2.00		
3.48	1.00	13.13	12.13	10.00	2.07	1.65	2.52	2.08	2.00		
4.50	1.59	12.27	10.68	10.00	2.09	1.65	2.54	2.28	2.00		
2.90	0.92	11.45	10.53	10.00	1.84	1.65	2.23	2.68	2.00	$19.30	$17.58
1.69	0.33	7.15	6.82	6.00	2.56	2.47	3.11	8.67	5.00		
1.44	0.49	7.33	6.84	6.00	2.49	2.47	3.03	5.20	5.00		
1.57	0.41	7.24	6.83	6.00	2.53	2.47	3.07	6.94	5.00	$20.96	$18.32
2.28	0.47	9.38	8.91	9.00	2.10	1.65	2.55	2.82	2.00		
3.07	0.88	9.45	8.57	9.00	2.72	1.65	3.31	3.28	2.00		
4.01	1.07	10.58	9.51	9.00	1.87	1.65	2.27	2.74	2.00		
3.12	0.81	9.80	9.00	9.00	2.23	1.65	2.71	2.95	2.00	$19.13	$16.51
1.88	0.56	10.38	9.82	9.00	1.84	1.65	2.24	2.40	2.00		
2.43	0.47	10.38	9.91	9.00	1.80	1.65	2.19	3.26	2.00		
1.67	0.23	9.95	9.72	9.00	1.81	1.65	2.20	2.02	2.00		
2.11	0.89	10.00	9.11	9.00	1.65	1.65	2.01	3.00	2.00		
2.43	0.87	12.20	11.33	9.00	1.70	1.65	2.06	3.12	2.00		
2.85	0.65	13.00	12.35	9.00	1.80	1.65	2.19	2.36	2.00		
2.97	1.05	12.50	11.45	9.00	2.39	1.65	2.90	2.40	2.00		
2.43	0.94	10.25	9.31	9.00	1.95	1.65	2.37	2.30	2.00		
2.45	0.97	10.50	9.53	9.00	1.94	1.65	2.36	2.00	2.00		
2.84	0.36	9.73	9.37	9.00	1.56	1.65	1.90	2.78	2.00		
2.68	0.67	9.83	9.16	9.00	1.58	1.65	1.92	2.42	2.00		
3.50	0.30	10.93	10.63	9.00	1.70	1.65	2.07	2.50	2.00		
2.35	0.45	10.03	9.58	9.00	2.18	1.65	2.65	2.60	2.00		
2.93	1.65	10.98	9.33	9.00	1.65	1.65	2.01	1.76	2.00		
2.54	0.72	10.76	10.04	9.00	1.83	1.65	2.22	2.49	2.00	$18.59	$16.51

COMPLETE

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	Phosphoric Acid—Water soluble Found %
Gulfport Cotton Oil, Fertilizer and Manufacturing Co.—Continued.			
Standard Primo Raw Bone Superphosphate....	2234	1	8.23
	2282	5	6.63
	2341	2	7.65
	2406	1	7.38
	2428	1	6.80
	2509	1	7.60
	2557	2	7.88
	2762	3	7.30
	2884	2	7.13
	2978	1	7.78
	3148	1	9.25
	3294	3	6.70
	3479	19	7.08
	3739	1	5.75
	3879	3	7.65
	3950	2	8.65
	4127	1	5.60
Average		49	7.36
Hazlehurst Oil Mill and Fertilizer Co. **Hazlehurst, Miss.**			
Imperial	2233	1	7.65
	2273	4	6.55
	2326	1	6.75
	2359	2	6.65
	2387	2	6.83
	2399	1	7.65
	2429	1	6.85
	2493	2	7.53
	2564	3	7.63
	2635	2	7.55
	2769	2	7.45
	2916	9	7.38
	3434	3	6.98
	3830	8	6.25
	3952	3	5.88
	4055	2	7.18
	4392	5	6.93
Average		51	7.04

FERTILIZERS.

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
			Available								
Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd	Found %	Guarant'd %		Found %	Guarant'd %	Found	Guarant'd
2.83	0.67	11.73	11.06	9.00	1.84	1.65	2.24	2.00	2.00		
2.46	0.66	9.75	9.09	9.00	1.65	1.65	2.00	2.60	2.00		
2.22	0.73	10.60	9.87	9.00	1.65	1.65	2.00	2.80	2.00		
2.93	1.17	11.48	10.31	9.00	1.34	1.65	1.63	3.00	2.00		
1.88	1.27	9.95	8.68	9.00	1.65	1.65	2.01	2.82	2.00		
3.33	1.22	12.15	10.93	9.00	1.65	1.65	2.01	3.12	2.00		
2.52	1.10	11.50	10.40	9.00	1.56	1.65	1.90	3.12	2.00		
2.37	0.86	10.53	9.67	9.00	1.78	1.65	2.16	2.70	2.00		
2.89	0.91	10.93	10.02	9.00	1.48	1.65	1.80	2.84	2.00		
2.67	0.73	11.18	10.45	9.00	1.65	1.65	2.01	3.30	2.00		
3.07	0.36	12.68	12.32	9.00	1.93	1 65	2.35	2.02	2.00		
3.15	0.80	10.65	9.85	9 00	1.76	1.65	2.14	2.66	2.00		
3.09	0.76	10.93	10.17	9.00	1.90	1.65	2.31	2.64	2.00		
3.37	1.86	10.98	9.12	9.00	2.95	1.65	3.59	3.00	2.00		
3.01	0.62	11.28	10.66	9.00	1.78	1.65	2.16	2.22	2.00		
3.69	0.90	13.24	12.34	9.00	1.33	1.65	1.62	1.68	2.00		
4.11	1.07	10.78	9.71	9.00	2.14	1.65	2.60	2.40	2.00		
2.92	0.92	11.20	10.27	9.00	1.77	1.65	2.15	2.64	2.00	$18.76	$16.51

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
3.43	0.67	11.75	11.08	9.50	1.86	1.65	2.26	1.76	1.75		
2.65	1.58	10.78	9.20	9.50	1.87	1.65	2.28	2.52	1.75		
2.35	1.65	10.75	9.10	9.50	1.93	1.65	2.35	1.76	1.75		
2.06	1.81	10.52	8.71	9.50	1.71	1 65	2.08	2.86	1.75		
2.30	1.22	10.35	9.13	9.50	1.84	1.65	2.24	3.34	1 75		
1.84	1.04	10.53	9.49	9.50	1.90	1.65	2.31	2.60	1.75		
1.56	1.47	9.88	8.41	9.50	1.73	1.65	2.10	2.52	1.75		
2.49	1.08	11.10	10.02	9.50	1.68	1.65	2.04	2.54	1.75		
2.40	1.15	11.18	10.03	9.50	1.65	1.65	2.01	2.44	1.75		
2.50	1.58	11.63	10.05	9.50	1.57	1.65	1.91	2.34	1.75		
2.64	1.11	11.20	10.09	9.50	1.54	1.65	1.87	2.38	1.75		
2.77	1.30	11.45	10.15	9.50	1.65	1.65	2.01	2.52	1.75		
2.43	1.36	10.77	9.41	9.50	1.66	1.65	2.02	2.74	1.75		
3.16	1.32	10.73	9.41	9.50	1.66	1.65	2.02	2.40	1.75		
3.64	0.88	10.40	9.52	9.50	1.86	1.65	2.26	2.16	1.75		
3.80	1.77	12.75	10.98	9.50	1.51	1.65	1.84	1.64	1.75		
3.20	1.65	11.78	10.13	9.50	1.55	1 65	1.89	1.80	1.75		
2.66	1.33	11.03	9.70	9.50	1.72	1.65	2.09	2.37	1.75	$17.78	$16.85

COMPLETE

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	Phosphoric Acid—Water soluble Found %
Homer Cotton Oil Co., Homer, La.			
Claiborne Mixture No. 1	2836	1	7.15
	3637	1	6.88
	4355	1	6.18
Average		3	6.74
Jackson Fertilizer Co., Jackson, Miss.			
Chicago Raw Bone Superphosphate	3415	1	6.43
	3941	1	6.13
	4033	1	9.10
Average		3	7.22
Fruit and Vegetable	2410	1	4.45
	2505	1	4.90
	2577	1	4.65
	3946	1	4.73
Average		4	4.68
Royal "C" Brand	2448	1	7.53
	2507	1	7.55
	2563	3	7.55
	2886	1	7.03
	2997	3	7.15
	3425	2	7.05
	3669	2	7.30
	3951	2	7.08
	4056	6	7.30
	4216	1	6.43
	4270	2	8.35
Average		25	7.30
Meridian Fertilizer Co., Meridian, Miss.			
Meridian Blood and Bone	2454	2	6.25
	2471	1	6.75
	2714	1	6.93
	2776	2	7.05
	2888	1	7.05
	3063	2	6.77
	3155	2	6.68
	3426	1	7.85

FERTILIZERS.

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
			Available								
Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found %	Guarant'd %		Found %	Guarant'd %	Found	Guarant'd
4.21	1.49	12.85	11.36	10.00	2.13	1.75	2.59	0.66	0.50		
4.67	1.10	12.65	11.55	10.00	1.99	1.75	2.42	0.68	0.50		
3.70	1.05	10.93	9.88	10.00	1.95	1.75	2.37	1.38	0.50		
4.19	1.21	12.14	10.93	10.00	2.02	1.75	2.46	0.91	0.50	$18.89	$16.70
4.27	2.45	13.15	10.70	9.50	1.65	1.65	2.01	2.08	1.50		
3.69	1.08	10.90	9.82	9.50	1.89	1.65	2.30	1.50	1.50		
5.44	0.81	15.35	14.54	9.50	0.79	1.65	0.96	0.86	1.50		
4.47	1.45	13.13	11.69	9.50	1.44	1.65	1.76	1.48	1.50	$18.30	$16.65
1.94	1.16	7.55	6.39	6.00	3.05	3.00	3.71	4.22	4.00		
1.62	1.21	7.73	6.52	6.00	3.25	3.00	3.95	4.48	4.00		
1.55	1.38	7.58	6.20	6.00	3.30	3.00	4.01	4.14	4.00		
2.22	1.20	8.15	6.95	6.00	3.27	3.00	3.97	3.64	4.00		
1.83	1.24	7.75	6.52	6.00	3.22	3.00	3.91	4.12	4.00	$20.58	$19.22
2.32	1.63	11.48	9.85	9.50	1.72	1.65	2.09	2.34	1.80		
2.28	1.95	11.78	9.83	9.50	1.99	1.65	2.42	2.48	1.80		
2.07	2.06	11.68	9.62	9.50	1.68	1.65	2.04	2.48	1.80		
2.28	1.77	11.08	9.31	9.50	2.01	1.65	2.44	2.24	1.80		
2.54	1.61	11.30	9.69	9.50	2.01	1.65	2.44	2.26	1.80		
3.34	1.36	11.75	10.39	9.50	1.65	1.65	2.01	1.90	1.80		
3.51	1.37	12.18	10.81	9.50	1.78	1.65	2.16	1.36	1.80		
3.44	1.36	11.88	10.52	9.50	1.39	1.65	1.69	1.82	1.80		
3.30	0.75	11.35	10.60	9.50	1.51	1.65	1.84	2.30	1.80		
3.07	1.23	10.73	9.50	9.50	1.76	1.65	2.14	2.34	1.80		
2.62	0.58	11.55	11.97	9.50	1.46	1.65	1.77	2.44	1.80		
2.80	1.42	11.52	10.19	9.50	1.72	1.65	2.09	2.18	1.80	$18.15	$16.89
3.84	0.76	10.85	10.09	9.50	1.74	1.65	2.11	1.84	1.50		
3.89	0.56	11.20	10.64	9.50	1.72	1.65	2.09	1.84	1.50		
4.05	0.82	11.80	10.98	9.50	1.91	1.65	2.32	1.90	1.50		
3.97	0.66	11.68	11.02	9.50	1.66	1.65	2.02	1.62	1.50		
2.70	1.60	11.35	9.75	9.50	1.88	1.65	2.28	2.08	1.50		
4.05	0.82	11.80	10.98	9.50	1.91	1.65	2.32	1.90	1.50		
4.15	0.97	11.80	10.83	9.50	1.70	1.65	2.07	2.30	1.50		
2.56	0.87	11.28	10.41	9.50	1.88	1.65	2.28	2.16	1.50		

COMPLETE

Manufacturer or Jobber and Brand	Station umber	Number of samples composited	Phosphoric Acid—Water soluble Found %
Meridian Fertilizer Co., Meridian, Miss.—continued.			
	3846	1	5.73
	3980	1	6.78
	4046	3	6.08
Average		17	6.72
Meridian Home Mixture	2430	1	7.33
	2447	1	7.08
	2473	1	7.28
	2489	1	7.53
	2566	4	6.78
	2613	2	6.95
	2639	2	7.58
	2680	1	7.43
	2699	5	7.38
	2755	10	7.25
	2869	7	7.15
	2919	3	7.38
	2998	4	7.80
	3054	11	7.05
	3115	12	6.78
	3185	10	7.00
	3255	5	7.45
	3321	12	6.95
	3445	11	7.03
	3574	20	6.98
	3732	9	6.05
	3781	2	6.23
	3873	8	6.48
	4045	9	6.30
	4195	2	6.15
Average		154	7.02
Meridian Soluble Guano	2995	2	8.03
	3065	1	6.88
	3555	2	5.70
	3977	1	7.05
Average		6	6.92

FERTILIZERS.

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
Reverted Found %	Insoluble Found %	Total Found %	Available								
			Found %	Guarant'd %	Found %	Guarant'd %		Found %	Guarant'd %	Found	Guarant'd
4.74	1.26	11.73	10.47	9.50	1.92	1.65	2.33	1.94	1.50		
3.00	1.17	10.95	9.78	9.50	1.65	1.65	2.01	2.80	1.50		
4.49	1.21	11.78	10.57	9.50	1.66	1.65	2.02	2.18	1.50		
3.75	1.01	11.48	10.47	9.50	1.79	1.65	2.17	2.11	1.50	$18.62	$16.65
3.14	1.11	11.58	10.47	9.50	2.02	1.65	2.45	2.14	1.50		
3.66	0.81	11.55	10.74	9.50	2.07	1.65	2.52	2.05	1.50		
3.78	0.67	11.73	11.06	9.50	2.18	1.65	2.65	1.96	1.50		
3.54	0.91	11.98	11.07	9.50	2.09	1.65	2.54	2.02	1.50		
3.79	1.06	11.63	10.57	9.50	1.65	1.65	2.01	2.00	1.50		
4.32	0.38	12.15	11.27	9.50	1.70	1.65	2.07	2.16	1.50		
3.81	0.96	12.35	11.39	9.50	1.66	1.65	2.02	1.68	1.50		
4.22	0.60	12.25	11.65	9.50	1.72	1.65	2.09	1.88	1.50		
3.58	1.02	11.98	10.96	9.50	1.46	1.65	1.77	1.88	1.50		
3.59	1.11	11.95	10.84	9.50	1.65	1.65	2.01	2.00	1.50		
4.45	0.93	12.53	11.60	9.50	1.31	1.65	1.59	1.60	1.50		
4.41	0.76	12.55	11.79	9.50	1.25	1.65	1.52	1.80	1.50		
3.33	1.62	12.75	11.13	9.50	1.67	1.65	2.03	2.04	1.50		
3.79	1.26	12.13	10.87	9.50	1.67	1.65	2.03	2.38	1.50		
3.56	0.91	11.25	10.34	9.50	1.73	1.65	2.10	2.06	1.50		
3.38	1.40	11.78	10.38	9.50	1.67	1.65	2.03	1.50	1.50		
3.27	1.11	11.83	10.72	9.50	1.48	1.65	1.80	1.76	1.50		
3.80	1.28	12.03	10.75	9.50	1.65	1.65	2.01	1.94	1.50		
3.84	1.01	11.88	10.87	9.50	1.65	1.65	2.01	1.90	1.50		
3.92	0.95	11.85	10.90	9.50	1.72	1.65	2.09	2.06	1.50		
3.35	0.95	10.35	9.40	9.50	1.77	1.65	2.15	2.20	1.50		
3.52	1.25	11.00	9.75	9.50	1.79	1.65	2.18	2.28	1.50		
3.85	0.75	11.08	10.33	9.50	1.70	1.65	2.07	1.90	1.50		
4.05	0.90	11.25	10.35	9.50	1.65	1.65	2.01	1.88	1.50		
3.71	1.52	11.38	9.86	9.50	1.70	1.65	2.07	1.58	1.50		
3.75	1.03	11.79	10.76	9.50	1.70	1.65	2.07	1.95	1.50	$18.51	$16.65
3.70	1.47	13.20	11.73	9.50	1.65	1.65	2.01	1.66	1.50		
3.32	1.10	11.30	10.20	9.50	2.24	1.65	2.72	3.00	1.50		
3.47	2.43	11.60	9.17	9.50	1.73	1.65	2.10	1.68	1.50		
3.81	1.04	11.90	10.86	9.50	1.80	1.65	2.19	2.44	1.50		
3.58	1.51	12.00	10.49	9.50	1.86	1.65	2.26	2.20	1.50	$18.94	$16.65

COMPLETE

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	Phosphoric Acid—Water soluble Found %
Meridian Fertilizer Co., Shreveport, La.			
Meridian Soluble Guano	2532	1	7.15
	2861	1	6.90
	3240	1	6.78
	3473	1	7.00
	3740	1	5.48
	3823	1	6.55
Average		6	6.64
Meridian Vegetable Grower	2449	1	5.93
	2756	4	6.25
	2860	1	6.08
	3241	1	5.93
Average		7	6.05
Minden Cotton Oil and Ice Co., Minden, La.			
North Louisiana Standard	3123	2	8.53
	3174	4	8.20
	3424	2	8.08
	3673	2	8.43
	3725	1	8.68
	3874	2	7.95
	4049	2	6.88
	4182	1	6.75
	4326	2	6.28
Average		18	7.75
Mississippi Fertilizer Co., Jackson, Miss.			
High-Grade Mississippi Fruit and Vegetable	2345	1	3.80
Standard Horse Shoe Brand Fertilizer	3418	1	7.03
New Orleans Acid and Fertilizer Co., Gretna, La.			
Ammoniated Raw Bone Superphosphate and Potash	2285	2	7.88
	2383	1	7.88
	2421	1	7.80
	2467	2	6.83
	2490	2	7.25
	2705	3	7.30

FERTILIZERS.

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
			Available								
Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found %	Guarant'd %		Found %	Guarant'd %	Found	Guarant'd
3.03	2.15	12.33	10.18	9.50	1.46	1.65	1.77	1.52	1.50		
4.49	0.86	12.25	11.39	9.50	1.46	1.65	1.77	2.00	1.50		
3.36	1.41	11.55	10.14	9.50	1.74	1.65	2.11	1.80	1.50		
3.41	0.87	11.28	10.41	9.50	1.81	1.65	2.20	2.23	1.50		
3.21	0.66	9.35	8.69	9.50	1.77	1.65	2.15	2.18	1.50		
3.16	1.32	11.03	9.71	9.50	1.61	1.65	1.96	2.32	1.50		
3.44	1.21	11.30	10.09	9.50	1.64	1.65	1.99	2.01	1.50	$17.65	$16.65
3.02	0.65	9.60	8.95	8.00	2.59	2.50	3.15	6.83	5.00		
3.10	0.85	10.20	9.35	8.00	2.49	2.50	3.03	6.56	5.00		
2.86	0.96	9.90	8.94	8.00	2.65	2.50	3.23	5.04	5.00		
3.09	0.91	9.93	9.02	8.00	2.33	2.50	2.83	5.18	5.00		
3.02	0.84	9.91	9.07	8.00	2.52	2.50	3.06	5.90	5.00	$22.49	$20.56
4.63	1.37	14.53	13.16	10.00	1.41	1.75	1.71	0.50	0.50		
4.83	1.45	14.48	13.03	10.00	1.43	1.75	1.74	0.66	0.50		
4.94	1.28	14.30	13.02	10.00	1.49	1.75	1.81	0.50	0.50		
4.25	1.50	14.18	12.68	10.00	0.96	1.75	1.17	0.58	0.50		
4.41	1.54	14.63	13.09	10.00	0.96	1.75	1.17	0.56	0.50		
4.51	1.12	13.58	12.46	10.00	1.19	1.75	1.45	0.50	0.50		
4.42	1.20	12.50	11.30	10.00	2.05	1.75	2.49	0.50	0.50		
4.34	1.21	12.30	11.09	10.00	2.10	1.75	2.55	0.34	0.50		
4.74	1.11	12.13	11.02	10.00	2.13	1.75	2.59	0.52	0.50		
4.56	1.31	13.62	12.31	10.00	1.52	1.75	1.85	0.52	0.50	$18.45	$16.70
2.47	0.36	6.63	6.27	6.00	2.74	3.00	3.33	3.86	4.00	$18.56	$19.22
2.75	0.80	10.58	9.78	9.50	1.73	1.65	2.10	2.82	1.80	$18.26	$16.89
2.69	0.16	10.73	10.57	9.00	2.50	1.65	3.04	1.72	1.50		
1.85	0.35	10.08	9.73	9.00	1.87	1.65	2.27	2.02	1.50		
1.87	0.36	10.03	9.67	9.00	1.43	1.65	1.74	1.72	1.50		
2.10	0.12	9.05	8.93	9.00	1.74	1.65	2.11	1.62	1.50		
1.81	0.04	9.10	9.06	9.00	1.78	1.65	2.16	1.28	1.50		
2.81	0.12	10.23	10.11	9.00	2.15	1.65	2.61	1.34	1.50		

			COMPLETE
Manufacturer or Jobber and Brand	Station Number	Number of samples composited	Phosphoric Acid—Water soluble Found %
New Orleans Acid and Fertilizer Co.—Continued.			
	2759	4	7.73
	2942	2	7.38
	3067	1	7.08
	3181	9	7.58
	3293	10	7.30
	3354	1	6.78
	3448	20	7.18
	3573	8	7.75
	3710	5	7.05
	3872	3	7.03
	3938	1	6.68
	3979	1	6.28
	4217	1	5.38
	4347	1	5.28
	4372	1	6.25
Average		79	7.03
Blood, Bone and Beef	2715	1	7.48
	2775	2	7.48
	2911	2	6.80
	3326	3	7.45
	3898	2	6.08
	4110	1	5.85
Average		11	6.86
Blood, Bone and Potash	2281	2	8.38
	2382	1	7.48
	2420	1	7.50
	450	1	8.48
	2472	1	7.08
	2494	4	7.78
	2517	3	7.10
	2703	4	7.28
	2807	1	7.43
	2937	3	7.60
	3035	2	7.05
	3178	6	7.73
	3298	7	6.90
	3384	5	7.33
	3565	5	7.65
	3760	1	4.25
	3842	1	7.08

FERTILIZERS.

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
			Available								
Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found %	Guarant'd %		Found %	Guarant'd %	Found	Guarant'd
2.26	0.31	10.30	9.99	9.00	1.65	1.65	2.01	1.72	1.50		
1.49	0.31	9.18	8.87	9.00	1.92	1.65	2.33	1.94	1.50		
2.33	0.12	9.53	9.41	9.00	1.95	1.65	2.37	1.72	1.50		
2.39	0.11	10.08	9.97	9.00	1.45	1.65	1.76	2.46	1.50		
3.38	0.90	11.58	10.68	9.00	1.43	1.65	1.74	1.92	1.50		
2.35	1.12	10.25	9.13	9.00	1.45	1 65	1.76	1.68	1.50		
3.00	1.30	11.48	10.18	9.00	1.32	1.65	1.60	1.18	1.50		
2.49	1.11	11.35	10.24	9.00	1.28	1 65	1.55	1.52	1.50		
2.16	0.87	10.08	9.21	9.00	1.39	1.65	1.69	1.50	1.50		
1.97	0.68	9.68	9.00	9.00	1.65	1.65	2.01	1.50	1.50		
2.30	0.70	9.68	8.98	9.00	1.74	1.65	2.11	1.84	1.50		
2.05	0.45	8.78	8.33	9.00	1.99	1.65	2.42	2.08	1.50		
3.39	0.13	8.90	8.77	9.00	1.66	1.65	2.02	2.06	1.50		
3.90	0.15	9.33	9.18	9.00	1.74	1.65	2.12	1.18	1.50		
2.31	0.22	8.78	8.56	9.00	1.65	1.65	2.01	1.24	1.50		
2.42	0.46	9.91	9.46	9.00	1.70	1.65	2.07	1.68	1.50	$16.91	$16.11
2.20	0.22	9.90	9.68	9.00	1.76	1.65	2.14	1.44	1.50		
2.02	0.20	9.70	9.50	9.00	1.46	1.65	1.77	1.94	1.50		
1.91	0.22	8.93	8.71	9.00	1.81	1.65	2.20	1.56	1.50		
3.45	1.23	12.13	10.90	9.00	1.49	1.65	1.81	1.82	1.50		
3.00	0.67	9.75	9.08	9.00	1.24	1.65	1.51	1.50	1.50		
2.47	0.51	8.83	8.32	9.00	1.60	1.65	1.94	2.10	1.50		
2.51	0.51	9.87	9.37	9.00	1.56	1.65	1.90	1.73	1.50	$16.40	$16.11
2.65	0.22	11.25	11.03	9.00	1.58	1.65	1.92	1.80	1.50		
2.19	0.11	9.78	9.67	9.00	1.94	1.65	2.36	1.66	1.50		
1.90	0.40	9.80	9.40	9.00	1.32	1.65	1.60	2.00	1.50		
2.75	0.15	11.38	11.23	9.00	1.65	1.65	2.01	1.85	1.50		
1.75	0.10	8.93	8.83	9.00	1.61	1.65	1.96	1.60	1.50		
2.15	0.25	10.18	9.93	9.00	1.65	1.65	2.01	1.42	1.50		
2.30	0.23	9.63	9.40	9.00	1.78	1.65	2.16	1.76	1.50		
2.36	0.14	9.78	9.64	9.00	1.78	1.65	2.16	1.46	1.50		
2.03	0.12	9.58	9.46	9.00	1.66	1.65	2.02	2.18	1.50		
1.63	0.25	9.48	9.23	9.00	1.82	1.65	2.21	1.72	1.50		
1.63	0.30	8.98	8.68	9.00	1.67	1.65	2.03	1.72	1.50		
2.16	0.21	10.10	9.89	9.00	1.66	1.65	2.02	1.62	1.50		
2.99	0.91	10.80	9.89	9.00	1.42	1.65	1.73	1.30	1.50		
2.37	1.30	11.00	9.70	9.00	1.73	1.65	2.10	1.16	1.50		
2.26	1.07	10.98	9.91	9.00	1.33	1.65	1.62	2.06	1.50		
1.93	0.45	6.63	6.18	9.00	1.91	1.65	2.32	1.32	1.50		
2.25	0.85	10.18	9.33	9.00	2.05	1.65	2.49	3.83	1.50		

COMPLETE

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	Phosphoric Acid—Water soluble Found %
New Orleans Acid and Fertilizer Co.—Continued.			
	3994	1	6.63
	4109	1	6.88
	4164	1	5.68
	4212	2	5.58
	4249	1	7.15
	4358	1	6.60
Average		55	7.07
"Economizer"	3635	1	5.95
	3758	1	7.63
	4247	1	7.33
Average		3	6.97
El Salvador Sugar Cane Fertilizer No. 675	3974	1	5.50
Gold Dust	2474	1	8.80
	2498	3	7.28
	2518	2	7.53
	2575	1	8.30
	2710	2	7.90
	2768	3	7.98
	2831	2	7.40
	2915	6	7.28
	3034	2	7.25
	3186	11	7.53
	3284	10	7.40
	3380	8	7.33
	3484	9	7.05
	3670	11	6.53
	3728	5	6.85
	3782	4	6.08
	3875	6	7.18
	3940	1	6.70
	3995	5	5.55
	4103	3	6.83
	4131	1	5.45
	4156	3	6.73
	4213	2	6.38
	4248	1	6.55
	4309	1	6.48
	4346	1	6.18

FERTILIZERS.

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
			Available								
Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found %	Guarant'd %		Found %	Guarant'd %	Found	Guarant'd
2.70	0.80	10.13	9.33	9.00	1.41	1.65	1.71	1.84	1.50		
2.62	0.45	9.95	9.50	9.00	1.53	1.65	1.86	1.24	1.50		
3.19	0.21	9.08	8.87	9.00	1.85	1.65	2.25	2.00	1.50		
3.06	0.16	8.80	8.64	9.00	1.56	1.65	1.90	1.64	1.50		
2.83	0.37	10.35	9.98	9.00	1.44	1.65	1.75	1.60	1.50		
2.65	0.60	9.85	9.25	9.00	2.10	1.65	2.55	1.36	1.50		
2.36	0.42	9.85	9.43	9.00	1.67	1.65	2.03	1.75	1.50	$16.83	$16.11
2.90	0.90	9.75	8.85	10.00	1.73	1.65	2.10	2.04	2.00		
2.93	0.69	11.25	10.56	10.00	1.39	1.65	1.69	2.16	2.00		
3.80	0.65	11.78	11.13	10.00	2.59	1.65	3.15	2.18	2.00		
3.21	0.75	10.93	10.18	10.00	1.90	1.65	2.31	2.13	2.00	$18.68	$17.58
1.73	0.20	7.43	7.23	7.00	5.44	5.00	6.61	6.04	5.00	$29.98	$27.49
2.44	1.01	12.25	11.24	9.00	1.65	1.65	2.01	1.64	1.50		
2.61	1.21	11.10	9.89	9.00	1.74	1.65	2.11	1.98	1.50		
2.45	1.10	11.08	9.98	9.00	1.76	1.65	2.14	1.92	1.50		
2.67	1.03	12.00	10.97	9.00	1.10	1.65	1.34	2.14	1.50		
2.05	0.58	10.53	9.95	9.00	1.58	1.65	1.92	1.80	1.50		
2.10	1.10	11.18	10.08	9.00	1.45	1.65	1.76	1.80	1.50		
2.18	1.12	10.70	9.58	9.00	1.79	1.65	2.18	2.06	1.50		
2.50	0.90	10.68	9.78	9.00	1.69	1.65	2.05	1.94	1.50		
2.40	0.80	10.45	9.65	9.00	1.59	1.65	1.93	1.82	1.50		
1.82	0.20	9.55	9.35	9.00	1.44	1.65	1.75	1.98	1.50		
2.08	0.62	10.10	9.48	9.00	1.27	1.65	1.54	1.88	1.50		
2.85	0.85	11.03	10.18	9.00	1.34	1.65	1.63	1.76	1.50		
2.54	0.51	10.10	9.59	9.00	1.56	1.65	1.90	2.12	1.50		
2.95	0.55	10.03	9.48	9.00	1.58	1.65	1.92	2.00	1.50		
2.86	0.79	10.50	9.71	9.00	1.71	1.65	2.08	1.96	1.50		
3.38	0.67	10.13	9.46	9.00	1.71	1.65	2.08	1.84	1.50		
2.24	0.61	10.03	9.42	9.00	1.66	1.65	2.02	2.12	1.50		
3.00	0.60	10.30	9.70	9.00	1.73	1.65	2.10	1.82	1.50		
2.38	0.55	8.48	7.93	9.00	1.73	1.65	2.10	2.26	1.50		
3.16	1.51	11.50	9.99	9.00	1.71	1.65	2.08	1.68	1.50		
2.92	1.00	9.37	8.37	9.00	2.17	1.65	2.64	2.24	1.50		
3.17	1.35	11.25	9.90	9.00	1.75	1.65	2.13	1.96	1.50		
3.15	1.27	10.80	9.53	9.00	1.65	1.65	2.01	1.20	1.50		
2.96	1.07	10.58	9.51	9.00	1.60	1.65	1.95	1.34	1.50		
4.15	0.90	11.53	10.63	9.00	1.65	1.65	2.01	1.12	1.50		
4.33	0.74	11.25	10.51	9.00	1.75	1.65	2.13	1.14	1.50		

COMPLETE

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	Phosphoric Acid—Water soluble Found %
New Orleans Acid and Fertilizer Co.—Continued.			
	4353	1	5.73
	4359	1	5.68
	4371	1	6.33
	4381	1	6.03
	4390	1	7.00
	4395	1	6.25
Average		110	6.86
Goldsmith's Improved Mixture	2486	4	7.43
	2526	2	7.73
	2579	1	8.53
	2709	2	7.70
	2764	4	7.25
	2914	2	7.50
	3036	2	6.75
	3180	6	8.00
	3285	8	7.63
	3381	8	6.68
	3483	4	6.65
	3671	4	6.40
	3763	1	7.13
	3868	1	7.40
	3981	1	6.78
Average		50	7.30
Vegetable Grower	2485	1	6.93
	2574	1	4.50
	2720	1	5.20
	2842	1	2.00
	2893	1	3.10
	2973	1	2.48
	3239	3	3.75
	3475	1	4.13
	3699	1	3.50
Average		11	3.95
Planters' Fertilizer and Chemical Co., **New Orleans, La.**			
Blood, Bone and Potash	2236	1	5.85
	2830	3	6.15
Average		4	6.00

COMPLETE

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
			Available								
Reverted Found ½	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found %	Guarant'd %		Found %	Guarant'd %	Found	Guarant'd
4.11	0.74	10.58	9.84	9.00	1.84	1.65	2.24	1.26	1.50		
4.22	0.45	10.35	9.90	9.00	1.81	1.65	2.20	1.16	1.50		
3.56	0.21	10.10	9.89	9.00	1.86	1.65	2.26	1.58	1.50		
3.63	1.39	11.05	9.66	9.00	1.82	1.65	2.21	0.86	1.50		
3.19	1.09	11.28	10.19	9.00	1.65	1.65	2.01	1.46	1.50		
3.94	1.06	11.25	10.19	9.00	1.85	1.65	2.25	1.02	1.50		
——	——	——	——	——	——	——	——	——	——	——	——
2.94	0.86	10.66	9.80	9.00	1.66	1.65	2.02	1.71	1.50	$17.17	$16.31
2.38	1.02	10.83	9.81	9.00	1.92	1.65	2.33	1.70	1.50		
2.29	1.28	11.30	10.02	9.00	1.39	1.65	1.69	1.56	1.50		
2.47	0.93	11.93	11.00	9.00	1.03	1.65	1.25	2.00	1.50		
2.00	0.53	10.23	9.70	9.00	1.81	1.65	2.20	2.14	1.50		
2.48	1.05	10.78	9.73	9.00	1.72	1.65	2.09	1.50	1.50		
2.39	0.81	10.70	9.89	9.00	1.57	1.65	1.91	2.04	1.50		
2.07	0.61	9.43	8.82	9.00	1.97	1.65	2.39	1.86	1.50		
1.82	0.28	10.10	9.82	9.00	1.41	1.65	1.71	1.70	1.50		
1.80	0.27	9.70	9.43	9.00	1.22	1.65	1.48	1.86	1.50		
2.36	0.66	9.70	9.04	9.00	1.64	1.65	1.99	1.66	1.50		
3.06	0.62	10.33	9.71	9.00	1.65	1.65	2.01	1.96	1.50		
2.88	0.37	9.65	9.28	9.00	1.65	1.65	2.01	1.50	1.50		
2.16	0.75	10.48	9.73	9.00	1.42	1.65	1.73	1.68	1.50		
2.45	0.60	10.45	9.85	9.00	1.85	1.65	2.25	1.80	1.50		
2.67	0.75	10.20	9.45	9.00	1.31	1.65	1.59	2.40	1.50		
——	——	——	——	——	——	——	——	——	——	——	——
2.35	0.70	10.39	9.69	9.00	1.57	1.65	1.91	1.82	1.50	$16.85	$16.31
1.95	1.15	10.03	8.88	6.00	1.52	2.47	1.85	4.26	4.00		
3.93	1.47	9.90	8.43	6.00	2.19	2.47	2.66	6.44	4.00		
2.43	0.35	7.98	7.63	6.00	2.53	2.47	3.07	3.84	4.00		
4.67	1.06	7.73	6.67	6.00	3.23	2.47	3.93	3.94	4.00		
4.08	0.85	8.03	7.18	6.00	3.47	2.47	4.22	3.72	4.00		
3.98	0.72	7.18	6.46	6.00	2.32	2.47	2.82	6.79	4.00		
2.93	0.17	6.85	6.68	6.00	2.72	2.47	3.31	4.72	4.00		
1.87	0.08	6.08	6.00	6.00	2.72	2.47	3.31	4.00	4.00		
2.39	0.26	6.15	5.89	6.00	2.48	2.47	3.01	4.96	4.00		
——	——	——	——	——	——	——	——	——	——	——	——
3.14	0.68	7.77	7.09	6.00	2.58	2.47	3.13	4.74	4.00	$19.63	$17.52
3.31	0.72	9.88	9.16	9.50	2.29	1.65	2.78	1.58	1.50		
3.02	1.76	10.93	9.17	9.50	1.69	1.65	2.05	2.06	1.50		
——	——	——	——	——	——	——	——	——	——	——	——
3.17	1.24	10.41	9.17	9.50	1.99	1.65	2.42	1.82	1.50	$17.64	$16.65

COMPLETE

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	Phosphoric Acid—Water soluble Found %
Planters' Fertilizer and Chemical Co.—Continued.			
Planters' Cotton and Corn Fertilizer No. 1	2231	2	8.48
	2468	2	8.93
	2496	3	7.78
	2530	1	8.58
	2711	2	8.25
	2806	5	6.10
	2891	1	6.93
	3059	3	3.13
	3161	3	6.05
	3254	4	6.10
	3323	3	5.78
	3442	8	6.40
	3554	2	6.65
	3705	4	5.90
	3778	1	7.23
	3886	1	7.63
	4129	1	7.55
	4278	2	7.73
Average		48	6.96
Planters' Golden Mixture	2537	1	8.23
	2889	1	6.93
	2933	1	7.18
	3062	2	5.93
	3172	5	5.43
	3485	10	6.22
	3698	1	5.83
Average		23	6.54
Planters' Raw Bone Superphosphate...........	2237	1	2.68
	2425	2	8.15
	2470	1	6.83
	2488	4	6.88
	2535	1	6.60
	2707	2	7.40
	2805	5	6.95
	2890	1	7.75
	2941	2	8.00
	3033*	2	5.85
	3170*	4	6.40
	3282*	4	6.33

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* Leather was found present in these samples.

FERTILIZERS.

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
			Available								
Reverted Found	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found %	Guarant'd %		Found %	Guarant'd %	Found	Guarant'd
3.34	0.80	12.62	11.82	9.50	2.18	1.65	2.65	0.52	1.50		
2.70	0.72	12.35	11.63	9.50	1.38	1.65	1.68	1.40	1.50		
2.45	1.02	11.25	10.23	9.50	1.96	1.65	2.38	2.14	1.50		
2.54	1.21	12.33	11.12	9.50	1.45	1.65	1.76	1.52	1.50		
2.48	0.90	11.63	10.73	9.50	2.03	1.65	2.46	1.82	1.50		
2.95	1.85	10.90	9.05	9.50	1.82	1.65	2.21	1.44	1.50		
2.79	1.66	11.38	9.72	9.50	1.81	1.65	2.20	1.88	1.50		
2.53	0.62	6.28	5.66	9.50	1.83	1.65	2.22	3.65	1.50		
3.23	1.97	11.25	9.28	9.50	2.01	1.65	2.44	2.18	1.50		
2.38	1.15	9.63	8.48	9.50	2.11	1.65	2.56	1.68	1.50		
2.53	0.92	9.23	8.31	9.50	1.67	1.65	2.03	1.68	1.50		
2.96	1.37	10.73	9.36	9.50	1.78	1.65	2.16	1.72	1.50		
3.58	1.42	11.65	10.23	9.50	1.92	1.65	2.33	1.36	1.50		
3.50	1.40	10.80	9.40	9.50	1.81	1.65	2.20	1.50	1.50		
2.42	0.55	10.20	9.65	9.50	1.65	1.65	2.01	2.78	1.50		
1.77	0.98	10.38	9.40	9.50	1.79	1.65	2.18	3.27	1.50		
2.73	0.72	11.00	10.28	9.50	2.01	1.65	2.44	2.92	1.50		
3.27	0.85	11.85	11.00	9.50	2.13	1.65	2.59	1.70	1.50		
2.79	1.12	10.86	9.74	9.50	1.85	1.65	2.25	1.95	1.50	$17.90	$16.65
1.96	1.81	12.00	10.19	9.50	1.70	1.65	2.07	2.20	1.50		
3.05	1.45	11.43	9.98	9.50	1.37	1.65	1.67	1.28	1.50		
2.79	1.56	11.53	9.97	9.50	1.79	1.65	2.18	1.52	1.50		
2.86	1.56	10.35	8.79	9.50	1.39	1.65	2.69	1.94	1.50		
2.50	1.52	9.45	7.93	9.50	1.40	1.65	1.70	2.20	1.50		
3.91	0.97	11.10	10.13	9.50	1.65	1.65	2.01	1.24	1.50		
3.50	1.17	10.50	9.33	9.50	1.78	1.65	2.16	1.93	1.50		
2.93	1.43	10.91	9.47	9.50	1.58	1.65	1.93	1.76	1.50	$16.60	$16.65
3.45	1.32	7.45	6.13	9.50	1.98	1.65	2.41	2.40	1.50		
2.17	1.18	11.50	10.32	9.50	1.42	1.65	1.73	1.83	1.50		
2.96	0.61	10.40	9.79	9.50	1.71	1.65	2.08	2.52	1.50		
2.51	1.41	10.80	9.39	9.50	1.69	1.65	2.05	2.28	1.50		
1.96	1.47	10.03	8.56	9.50	2.25	1.65	2.73	2.52	1.50		
2.62	1.51	11.53	10.02	9.50	1.36	1.65	1.65	1.80	1.50		
3.59	1.56	12.10	10.54	9.50	1.65	1.65	2.01	1.34	1.50		
2.90	1.40	12.05	10.65	9.50	1.84	1.65	2.24	1.32	1.50		
2.30	1.63	11.93	10.30	9.50	1.77	1.65	2.15	1.52	1.50		
3.00	0.73	9.58	8.85	9.50	1.83	1.65	2.22	2.26	1.50		
3.64	1.06	11.10	10.04	9.50	1.65	1.65	2.01	1.98	1.50		
3.36	1.46	11.15	9.69	9.50	1.65	1.65	2.01	1.40	1.50		

COMPLETE

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	Phosphoric Acid—Water soluble Found %
Planters' Fertilizer and Chemical Co.—Continued.			
	3443*	11	5.95
	3556*	2	5.65
	3700*	3	6.33
	3783*	5	5.80
	3895*	5	7.83
	3944*	1	7.35
	3990*	2	6.40
	4035*	1	5.25
	4272*	1	8.18
Average		60	6.60
Planters' Stubb's Cotton and Corn	2466	3	5.38
	2487	2	5.88
	2700	5	6.23
	2758	4	5.28
	2862	1	4.68
	3037	2	4.65
	3238	2	5.63
	3364	3	4.85
	3501	4	5.93
	3674	2	5.48
Average		28	5.40
Planters' Vegetable Grower	2232	1	7.23
	2506	1	6.58
	2536	1	6.43
	2721	1	6.80
	2865	1	6.18
	3552	1	5.95
Average		6	6.53
Ruston Oil Mill and Fertilizer Co., Ruston, La.			
Corn King Guano	3355	1	5.23
Cotton King Guano	3118	5	7.98
	3258	2	7.83
	3320	10	7.58
	3478	10	7.20

* Leather was found present in these samples.

FERTILIZERS.

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
			Available								
Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found %	Guarant'd %		Found %	Guarant'd %	Found	Guarant'd
3.22	1.71	10.88	9.17	9.50	1.87	1.65	2.27	1.50	1.50		
3.17	2.63	11.45	8.82	9.50	2.04	1.65	2.48	1.36	1.50		
3.86	2.41	12.60	10.19	9.50	1.65	1.65	2.01	1.16	1.50		
3.77	1.81	11.38	9.57	9.50	1.95	1.65	2.37	1.24	1.50		
2.70	0.72	11.25	10.53	9.50	1.79	1.65	2.18	1.12	1.50		
3.10	0.88	11.33	10.45	9.50	1.83	1.65	2.22	1.10	1.50		
3.00	1.13	10.53	9.40	9.50	2.15	1.65	2.61	1.76	1.50		
3.23	1.85	10.33	8.48	9.50	2.73	1.65	3.32	1.38	1.50		
3.70	0.55	12.43	11.88	9.50	1.89	1.65	2.30	1.06	1.50		
3.06	1.38	11.04	9.66	9.50	1.84	1.65	2.24	1.66	1.50	$17.55	$16.65
2.43	0.94	8.75	7.81	7.00	1.68	1.65	2.04	2.88	2.00		
1.91	0.86	8.65	7.79	7.00	1.65	1.65	2.01	2.58	2.00		
2.23	0.92	9.38	8.46	7.00	1.66	1.65	2.02	2.16	2.00		
1.87	1.28	8.43	7.15	7.00	1.83	1.65	2.22	2.26	2.00		
2.43	1.27	8.38	7.11	7.00	1.57	1.65	1.91	2.60	2.00		
2.33	0.85	7.83	6.98	7.00	1.80	1.65	2.19	2.34	2.00		
1.61	1.11	8.35	7.24	7.00	1.56	1.65	1.90	2.34	2.00		
2.39	0.81	8.05	7.24	7.00	1.65	1.65	2.01	2.52	2.00		
2.00	0.77	8.70	7.93	7.00	1.45	1.65	1.76	2.20	2.00		
2.66	3.01	11.15	8.14	7.00	1.51	1.65	1.84	2.72	2.00		
2.19	1.18	8.77	7.59	7.00	1.64	1.65	1.99	2.46	2.00	$15.34	$14.37
2.16	0.94	10.23	9.39	7.00	2.39	2.50	2.90	3.52	3.50		
2.36	1.16	10.10	8.94	7.00	2.65	2.50	3.22	2.84	3.50		
2.54	1.18	10.15	8.97	7.00	3.76	2.50	4.57	2.74	3.50		
1.23	0.91	8.94	8.03	7.00	2.38	2.50	2.89	3.52	3.50		
1.86	0.41	8.45	7.04	7.00	2.58	2.50	3.14	3.26	3.50		
2.61	2.02	10.58	8.56	7.00	1.81	2.50	2.20	2.84	3.50		
2.13	1.10	9.76	8.49	7.00	2.60	2.50	3.15	3.12	3.50	$19.90	$18.29
2.44	0.71	8.38	7.67	8.00	2.50	2.50	3.04	2.20	2.00	$17.97	$18.16
2.51	0.46	10.95	10.49	10.00	1.54	1.75	1.87	1.60	1.50		
2.17	0.45	10.45	10.00	10.00	1.78	1.75	2.16	1.64	1.50		
2.45	0.60	10.63	10.03	10.00	1.71	1.75	2.08	1.80	1.50		
2.83	0.80	10.83	10.03	10.00	1.58	1.75	1.92	1.88	1.50		

COMPLETE

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	Phosphoric Acid—Water soluble Found %
Ruston Oil Mill and Fertilizer Co.—Continued.			
	3707	14	7.58
	3759	1	7.08
	3949	5	7.18
	4160	3	7.50
	4277	2	5.85
Average		52	7.31
Sonia Cotton Oil Co., Alexandria, La.			
Sonia Corn Grower	3779	2	3.40
	4219	1	4.00
Average		3	3.70
Sonia Early Truck Grower	3780	2	6.10
Sonia Soluble Guano	3756	1	6.63
Standard Guano and Chemical Manufacturing Co., New Orleans, La.			
Blood, Bone and Meat	2335	2	7.25
	2388	1	6.25
	2394	1	5.95
	2403	1	6.70
	2501	1	7.95
	2520	3	7.53
	2561	2	7.60
	2637	5	7.85
	2674	1	8.03
	2698	6	8.05
	2761	3	7.85
	2825	3	7.88
	2880	2	6.20
	2923	3	7.10
	3004	4	6.85
	3057	3	7.68
	3179	5	6.78
	3317	9	6.80
	3446	6	7.00
	3871	2	6.35
	4006	1	5.83
Average		64	7.12

FERTILIZERS.

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
Reverted Found %	Insoluble Found %	Total Found %	Available Found %	Available Guarant'd %	Found %	Guarant'd %		Found %	Guarant'd %	Found	Guarant'd
2.02	1.38	10.98	9.60	10.00	1.59	1.75	1.93	2.48	1.50		
2.70	1.25	11.03	9.78	10.00	1.44	1.75	1.75	1.68	1.50		
3.97	1.28	12.43	11.15	10.00	1.98	1.75	2.41	1.28	1.50		
2.68	0.95	11.13	10.18	10.00	1.75	1.75	2.13	1.58	1.50		
3.77	1.01	10.63	9.62	10.00	2.08	1.75	2.53	1.66	1.50		
2.79	0.91	11.01	10.10	10.00	1.72	1.75	2.09	1.73	1.50	$17.70	$17.50
1.61	0.72	5.73	5.01	5.00	3.87	3.72	4.70	2.94	1.00		
2.82	0.56	7.38	6.82	5.00	3.52	3.72	4.28	2.22	1.00		
2.82	0.56	7.38	6.82	5.00	3.52	3.72	4.28	2.22	1.00		
2.22	0.64	6.56	5.92	5.00	3.70	3.72	4.49	2.58	1.00	$20.24	$18.05
2.42	1.26	9.78	8.52	8.00	2.36	2.48	2.87	4.10	4.00	$19.95	$19.70
2.30	1.35	10.28	8.93	8.00	1.55	1.65	1.88	2.72	2.00	$16.69	$15 44
2.95	1.68	11.88	10.20	9.50	1.92	1.65	2.34	2.58	1.50		
2.84	2.06	11.15	9.09	9.50	1.90	1.65	2.31	2.58	1.50		
3.67	1.43	11.05	9.62	9.50	1.89	1.65	2.30	2.14	1.50		
3.17	1.06	10.93	9.87	9.50	2.03	1.65	2.46	1.96	1.50		
3.25	1.45	12.65	11.20	9.50	1.55	1.65	1.88	2.12	1.50		
2.64	1.56	11.73	10.17	9.50	1.79	1.65	2.18	1.92	1.50		
2.65	1.75	12.00	10.25	9.50	2.02	1.65	2.45	2.52	1.50		
3.18	1.62	12.65	11.03	9.50	1.86	1.65	2.26	2.14	1.50		
3.30	1.45	12.78	11.33	9.50	1.77	1.65	2.15	1.54	1.50		
2.93	2.02	13.00	10.98	9.50	1.83	1.65	2.22	1.64	1.50		
2.77	2.18	12.80	10.62	9.50	1.89	1.65	2.30	1.50	1.50		
2.69	1.93	12.50	10.57	9.50	1.85	1.65	2.25	1.92	1.50		
3.25	1.78	11.23	9.45	9.50	2.82	1.65	3.43	2.86	1.50		
3.43	1.60	12.13	10.53	9.50	1.86	1.65	2.26	2.04	1.50		
3.50	1.53	11.88	10.35	9.50	2.05	1.65	2.49	2.16	1.50		
3.22	1.50	12.40	10.90	9.50	1.85	1.65	2.25	2.08	1.50		
3.58	1.72	12.08	10.36	9.50	1.85	1.65	2.25	1.94	1.50		
2.44	1.76	11.00	9.24	9.50	1.71	1.65	2.08	1.82	1.50		
2.95	1.48	11.43	9.95	9.50	1.77	1.65	2.15	1.78	1.50		
3.24	0.86	10.45	9.59	9.50	2.66	1.65	3.23	1.68	1.50		
3.69	1.48	11.00	9.52	9.50	1.76	1.65	2.14	3.04	1.50		
3.11	1.61	11.84	10.21	9.50	1.93	1.65	2.35	2.09	1.50	$18.77	$16.65

COMPLETE

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	Phosphoric Acid—Water soluble Found %
Standard Guano and Chemical Mfg. Co.—Continued.			
Champion Farmers' Choice	2230	3	8.05
	2278	22	6.83
	2357	3	6.75
	2369	1	6.20
	2391	1	6.85
	2396	1	7.38
	2405	1	7.53
	2424	2	7.40
	2451	2	7.73
	2495	4	7.40
	2527	1	7.35
	2558	2	8.18
	2634	4	7.33
	2670	6	8.30
	2701	5	7.65
	2771	3	7.20
	2824	3	7.65
	2879	4	7.48
	2920	8	7.78
	3001	5	7.33
	3053	8	7.48
	3114	7	7.50
	3217	6	7.20
	3286	10	7.30
	3383	9	7.03
	3486	22	7.48
	3676	4	7.53
	3768	7	7.10
	3881	10	7.05
	3997	7	7.20
	4030	1	7.83
	4158	5	7.78
	4198	3	7.15
	4234	10	6.63
	4329	3	7.10
	4361	6	6.85
	4368	2	6.70
	4385	2	6.05
	4394	1	6.25
	4398	1	7.53
Average		205	7.28
McCall's Formula	2772	2	4.63

FERTILIZERS.

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
			Available								
Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant' %	Found %	Guarant'd %		Found %	Guarant'd %	Found	Guarant'd
2.73	1.47	12.25	10.78	9.50	1.65	1.65	2.00	1.42	1.00		
3.60	1.22	11.65	10.43	9.50	2.00	1.65	2.43	2.72	1.00		
3.00	1.75	11.50	9.75	9.50	1.88	1.65	2.29	3.12	1.00		
3.39	2.16	11.75	9.59	9.50	1.86	1.65	2.26	2.32	1.00		
2.78	2.67	12.30	9.63	9.50	1.90	1.65	2.31	2.56	1.00		
3.50	2.07	12.95	10.88	9.50	1.84	1.65	2.24	2.10	1.00		
2.99	2.11	12.63	10.52	9.50	1.74	1.65	2.11	1.64	1.00		
2.15	2.00	11.55	9.55	9.50	1.65	1.65	2.01	2.59	1.00		
2.64	1.91	12.28	10.37	9.50	1.32	1.65	1.60	2.38	1.00		
2.94	1.71	12.05	10.34	9 50	1.65	1.65	2.01	2.06	1.00		
3.23	1.72	12.30	10.58	9.50	1.65	1.65	2.01	1.98	1.00		
3.14	1.86	13.18	11.32	9.50	1.56	1.65	1.90	2.60	1.00		
3.41	1.71	12.45	10.74	9.50	1.68	1.65	2.04	1.90	1.00		
2.77	1.83	12.90	11.07	9.50	1.70	1.65	2.07	1.66	1.00		
3.06	1.77	12.48	10.71	9.50	1.88	1.65	2.28	2.02	1.00		
2.53	2.15	11.88	9.73	9.50	1.86	1.65	2.26	1.46	1.00		
2.88	1.90	12.43	10.53	9.50	1.63	1.65	1.98	2.00	1.00		
3.25	1.65	12.38	10.73	9.50	1.89	1.65	2.30	2.04	1.00		
3.35	1.55	12.68	11.13	9.50	1.65	1.65	2.01	2.00	1.00		
3.40	1.67	12.40	10.73	9.50	2.05	1.65	2.49	2.04	1.00		
3.13	1.47	12.08	10.61	9.50	1.69	1.65	2.05	1.64	1.00		
3.32	1.31	12.13	10.82	9.50	1.68	1.65	2.04	1.48	1.00		
3.33	1.50	12.03	10.53	9.50	2.20	1.65	2.67	2.04	1.00		
2.37	2.23	11.90	9.67	9.50	1.77	1.65	2.15	1.82	1.00		
3.18	1.57	11.78	10.21	9.50	1.79	1.65	2.18	1.88	1.00		
3.31	1.26	12.05	10.79	9.50	1.94	1.65	2.36	1.64	1.00		
3.70	1.25	12.48	11.23	9.50	1.72	1.65	2.09	2.06	1.00		
2.89	2.41	12.40	9.99	9.50	1.40	1.65	1.70	2.22	1.00		
2.95	1.90	11.90	10.00	9.50	1.70	1.65	2.07	1.52	1.00		
2.75	1.68	11.63	9.95	9.50	1.77	1.65	2.15	2.40	1.00		
3 15	1.32	12.30	10.98	9.50	1.49	1.65	1.81	1.94	1.00		
2.98	1.32	12.08	10.76	9.50	1.65	1.65	2.01	1.90	1.00		
3.60	1.25	12.00	10.75	9.50	2.04	1.65	2.48	1.64	1.00		
3.44	1.06	11.13	10.07	9.50	2.45	1.65	2.98	1.94	1.00		
3.08	1.22	11.40	10.18	9.50	2.38	1.65	2.89	2.12	1.00		
3.96	0.92	11.73	10.81	9.50	1.65	1.65	2.01	1.54	1.00		
2.29	0.89	10.88	9.99	9.50	1.82	1.65	2.21	1.76	1.00		
3.54	0.69	10.28	9.59	9.50	2.50	1.65	3.04	1.96	1.00		
3.59	0.46	10.30	9.84	9.50	2.41	1.65	2.94	1.68	1.00		
3.39	1.31	12.23	10.92	9.50	1.92	1.65	2.34	1.44	1.00		
3.14	1.60	12.02	10.42	9.50	1.83	1.65	2.22	1.98	1.00	$18.59	$16.25
2.00	3.40	10.03	6.63	5.00	3.85	3.85	4.68	1.78	1.00		

COMPLETE

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	Phosphoric Acid—Wator soluble Found %
Standard Guano and Chemical Mfg. Co.—Continued.			
	2864	1	4.78
	3433	2	4.80
	3572	10	5.40
	3701	3	3.43
	4240	1	3.58
	4324	1	4.03
	4360	1	3.95
Average		21	4.33
Mississippi Home Guano	2275	2	6.45
	2528	1	8.40
	2578	1	8.50
	2638	2	7.48
	2834	1	7.53
	2975	1	7.76
	3003	2	7.35
	3145	1	7.58
	3358	5	6.98
	3561	2	7.35
	4239	1	6.83
	4325	1	7.65
Average		20	7.49
Orange and Fruit Tree Fertilizer*	2407	1	
	2540	1	
	3755	1	
Average		3	
Special Formula	2347	1	6.08
Standard Ammoniated Soluble Guano	2974	1	6.58
	3477	1	6.65
Average		2	6.62
Standard High Grade Truck Grower	2390	1	7.03
	2539	1	7.08

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* The phosphoric acid and nitrogen in this fertilizer are valued as in a bone meal. The phosphoric acid is guaranteed 15 per cent insoluble.

FERTILIZERS.

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
			Available								
Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found %	Guarant'd %		Found %	Guarant'd %	Found	Guarant'd
2.75	3.15	10.68	7.53	5.00	3.85	3.85	4.68	1.28	1.00		
2.72	3.63	11.15	7.52	5.00	3.26	3.85	3.96	1.88	1.00		
2.94	3.36	11.70	8.34	5.00	3.57	3.85	4.34	1.96	1.00		
2.52	2.85	8.80	5.95	5.00	3.66	3.85	4.45	1.90	1.00		
3.08	0.67	7.33	6.66	5.00	3.85	3.85	4.68	1.84	1.00		
2.96	0.94	7.93	6.99	5.00	3.63	3.85	4.41	1.40	1.00		
3.16	0.92	8.03	7.11	5.00	4.34	3.85	5.27	1.30	1.00		
2.77	2.37	9.46	7.09	5.00	3.75	3.85	4.56	1.67	1.00	$20.92	$18.47
3.70	0.75	10.90	10.15	9.50	2.00	1.65	2.43	3.48	1.50		
3.32	1.58	13.30	11.72	9.50	1.25	1.65	1.52	1.72	1.50		
2.74	1.61	12.85	11.24	9.50	1.79	1.65	2.18	1.88	1.50		
3.38	1.62	12.48	10.86	9.50	2.08	1.65	2.53	2.18	1.50		
2.35	2.20	12.08	9.88	9.50	1.79	1.65	2.18	2.12	1.50		
3.36	1.66	12.78	11.12	9.50	1.65	1.65	2.01	2.70	1.50		
2.87	1.43	11.65	10.22	9.50	1.99	1.65	2.42	2.14	1.50		
3.52	1.28	12.38	11.10	9.50	1.57	1.65	1.91	2.02	1.50		
3.25	1.52	11.75	10.23	9.50	1.65	1.65	2.01	2.46	1.50		
2.83	1.50	11.68	10.18	9.50	2.02	1.65	2.45	2.46	1.50		
3.45	1.95	12.23	10.28	9.50	1.92	1.65	2.33	1.24	1.50		
3.06	0.79	11.50	10.71	9.50	1.73	1.65	2.10	1.72	1.50		
3.15	1.49	12.13	10.57	9.50	1.79	1.65	2.17	2.18	1.50	$18.78	$16.65
	1.22	12.00	10.78		2.86	2.75	3.48	2.18	3.00		
	7.33	17.80	10.47		2.56	2.75	3.11	4.60	3.00		
	8.70	16.48	7.78		2.40	2.75	2.92	8.60	3.00		
	5.75	15.43	9.68		2.61	2.75	3.17	5.13	3.00	$25.84	$24.30
2.55	1.10	9.73	8.63	7.00	2.52	3.00	3.06	8.74	9.00	$24.29	$24 29
3.80	1.40	11.78	10.38	9 50	1.65	1.65	2.01	2.80	1.50		
3.38	1.37	11.40	10.03	9.50	1.74	1.65	2.11	1.56	1.50		
3.59	1.39	11.59	10.21	9.50	1.70	1.65	2.06	2.18	1.50	$18.11	$16.65
1.57	0.26	8.80	8.54	8.00	3.19	3.50	3.88	7.00	7.00		
1.64	0.83	9.55	8.72	8.00	3.73	3.50	4.53	7.00	7.00		

COMPLETE

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	Phosphoric Acid—Water soluble Found %
Standard Guano and Chemical Mfg. Co.—Continued.			
	2868	1	7.03
	2984	2	6.93
	4417	1	6.40
Average		6	6.89
Standard Sugar Cane	2346	1	6.30
	2404	1	5.33
	2673	1	8.70
	3548	1	8.00
	3709	2	7.93
	3824	1	6.30
	4193	1	6.93
	4243	1	6.60
Average		9	7.01
Stern's Ammoniated Raw Bone Superphosphate	2228	3	7.78
	2279	4	5.50
	2334	2	6.13
	2360	1	5.88
	2371	1	6.63
	2389	1	6.15
	2395	1	6.03
	2402	1	6.13
	2419	1	7.65
	2423	2	6.68
	2452	3	7.08
	2492	4	7.58
	2519	7	6.73
	2567	7	6.98
	2632	20	6.33
	2669	18	6.30
	2697	13	5.90
	2754	10	5.83
	2822	18	5.70
	2878	20	6.05
	2922	18	5.80
	2932	18	6.00
	3052	12	6.38
	3113	32	6.03
	3151	29	5.88
	3257	24	6.20
	3318	58	6.58
	3385	27	5.90

FERTILIZERS.

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
			Available								
Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found %	Guarant'd %		Found %	Guarant'd %	Found	Guarant'd
2.17	0.45	9.65	9.20	8.00	3.63	3.50	4.41	6.76	7.00		
1.89	0.38	9.20	8.82	8.00	3.92	3.50	4.76	7.60	7.00		
2.29	0.56	9.25	8.69	8.00	3.67	3.50	4.46	7.20	7.00		
2.29	0.56	9.25	8.69	8.00	3.67	3.50	4.46	7.20	7.00		
1.90	0.50	9.29	8.79	8.00	3.63	3.50	4.41	7.11	7.00	$26.71	$25.36
4.94	1.01	12.25	11.24	10.00	2.54	2.50	3.09	2.00	2.00		
3.35	1.50	10.18	8.68	10.00	2.63	2.50	3.20	3.50	2.00		
2.83	1.35	12.88	11.53	10.00	2.41	2.50	2.93	2.56	2.00		
2.81	1.97	12.78	10.81	10.00	2.38	2.50	2.89	2.06	2.00		
4.31	0.86	13.10	12.24	10.00	2.50	2.50	3.04	2.04	2.00		
3.42	1.63	11.35	9.72	10.00	2.60	2.50	3.16	2.54	2.00		
3.45	1.40	11.78	10.38	10.00	3.02	2.50	3.67	1.90	2.00		
3.99	0.96	11.55	10.59	10.00	2.36	2.50	2.87	1.68	2.00		
3.64	1.34	11.98	10.65	10.00	2.56	2.50	3.11	2.29	2.00	$21.42	$20.30
2.14	1.67	11.59	9.92	9.50	2.18	1.65	2.65	2.04	1.50		
3.57	0.86	9.93	9.07	9.50	2.77	1.65	3.37	2.94	1.50		
4.03	1.12	11.28	10.16	9.50	1.67	1.65	2.03	2.24	1.50		
3.42	2.00	11.30	9.30	9.50	1.87	1.65	2.28	2.62	1.50		
3.29	1.03	10.95	9.92	9.50	1.89	1.65	2.30	2.30	1.50		
3.20	1.93	11.28	9.35	9.50	1.93	1.65	2.35	2.34	1.50		
3.86	1.41	11.30	9.89	9.50	1.76	1.65	2.14	1.96	1.50		
3.34	2.06	11.53	9.47	9.50	2.02	1.65	2.45	1.94	1.50		
3.11	1.47	12.23	10.76	9.50	1.92	1.65	2.33	1.88	1.50		
3.50	1.30	11.48	10.18	9.50	1.78	1.65	2.16	1.99	1.50		
2.88	1.04	11.00	9.96	9.50	1.72	1.65	2.09	3.50	1.50		
2.69	1.43	11.70	10.27	9.50	1.65	1.65	2.01	1.96	1.50		
3.34	1.58	11.65	10.07	9.50	1.81	1.65	2.20	1.36	1.50		
3.01	1.71	11.70	9.99	9.50	1.65	1.65	2.01	2.20	1.50		
3.97	1.38	11.68	10.30	9.50	1.83	1.65	2.22	1.88	1.50		
4.31	1.32	11.93	10.61	9.50	1.81	1.65	2.20	2.10	1.50		
4.20	1.55	11.65	10.10	9.50	1.94	1.65	2.36	1.56	1.50		
4.32	1.55	11.70	10.15	9.50	1.88	1.65	2.28	1.72	1.50		
4.21	1.72	11.63	9.91	9.50	1.65	1.65	2.01	2.12	1.50		
4.65	1.25	11.95	10.70	9.50	1.66	1.65	2.02	2.10	1.50		
4.33	1.40	11.53	10.13	9.50	1.73	1.65	2.10	1.88	1.50		
4.27	1.56	11.83	10.27	9.50	1.82	1.65	2.21	1.64	1.50		
4.27	1.43	12.08	10.65	9.50	1.65	1.65	2.01	2.26	1.50		
4.72	0.95	11.70	10.75	9.50	1.87	1.65	2.27	1.78	1.50		
3.94	1.73	11.55	9.82	9.50	1.74	1.65	2.11	1.78	1.50		
3.40	1.75	11.35	9.60	9.50	1.89	1.65	2.30	1.60	1.50		
3.52	1.65	11.75	10.10	9.00	1.67	1.65	2.03	2.08	1.50		
3.71	1.57	11.18	9.61	9.50	1.65	1.65	2.01	1.54	1.50		

COMPLETE

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	Phosphoric Acid—Water soluble Found %
Standard Guano and Chemical Mfg. Co.—Continued.			
	3487	45	5.95
	3677	24	8.45
	3767	14	6.03
	3882	27	5.85
	3996	13	6.03
	4058	5	5.58
	4157	9	5.38
	4199	5	4.85
	4233	10	5.30
	4328	2	5.13
	4362	3	5.23
	4369	3	8.58
	4384	1	7.85
	4399	1	8.55
	4411	1	8.00
Average		518	6.39
Vegetable Fertilizer	2227	2	5.93
	2286	2	5.68
	2372	1	5.85
	2386	2	5.53
	2426	1	4.63
	2521	2	5.50
	2559	2	6.43
	2641	1	5.10
	2675	1	5.05
	2773	2	5.25
	2823	3	5.33
	2881	2	4.88
	2976	2	4.58
	3096	5	5.00
	3247	1	5.95
	3319	2	4.28
	3429	2	4.47
	3563	3	5.15
	3765	1	4.20
	3817	1	5.08
	3889	1	5.18
	4246	1	5.25
	4416	1	5.25
Average		41	5.19

FERTILIZERS.

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
			Available								
Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found %	Guarant'd %		Found %	Guarant'd %	Found	Guarant'd
4.50	1.05	11.50	10.45	9.50	1.65	1.65	2.01	1.82	1.50		
1.49	1.51	11.45	9.94	9.50	1.73	1.65	2.10	2.08	1.50		
3.95	1.17	11.15	9.98	9.50	1.65	1.65	2.01	1.78	1.50		
4.14	1.11	11.10	9.99	9.50	1.82	1.65	2.21	1.50	1.50		
4.39	1.23	11.65	10.42	9.50	2.25	1.65	2.73	2.44	1.50		
4.63	1.27	11.48	10.21	9.50	2.45	1.65	2.98	1.66	1.50		
4.75	1.30	11.43	10.13	9.50	1.83	1.65	2.22	1.72	1.50		
4.79	1.56	11.20	9.64	9.50	1.65	1.65	2.01	1.86	1.50		
5.19	1.36	11.85	10.49	9.50	1 91	1.65	2.32	1.72	1.50		
4.43	1.32	10.88	9.56	9.50	1.88	1.65	2.28	1.92	1.50		
5.15	1.15	11.53	10.38	9.50	1.90	1.65	2.31	1.74	1.50		
4.14	2.00	14.72	12.72	9.50	2.09	1.65	2.54	0.58	1.50		
3.51	1.82	13.18	11.36	9.50	3.36	1.65	4.09	0.84	1.50		
2.54	1.36	12.45	11.09	9.50	1.76	1.65	2.14	1.73	1.50		
2.90	1.30	12.20	10.90	9.50	1.65	1.65	2.01	1.60	1.50		
3.80	1.44	11.63	10.19	9.50	1.88	1.65	2.29	1.91	1.50	$18.45	$16.65
1.69	1.00	8.62	7.62	6.00	3.14	2.50	3.82	4.44	5.00		
1.92	0.65	8.25	7.60	6.00	2.80	2.50	3.40	5.46	5.00		
1.95	1.00	8.80	7.80	6.00	2.68	2.50	3.26	6.60	5.00		
2.30	1.45	9.28	7.83	6.00	2.60	2.50	3.16	5.36	5.00		
2.52	3.03	10.18	7.15	6.00	2.57	2.50	3.12	5.08	5.00		
2.25	1.00	8.75	7.75	6.00	2.63	2.50	3.20	5.04	5.00		
2.21	1.61	10.25	8.64	6.00	2.90	2.50	3.52	4.16	5.00		
2.92	1.46	9.48	8.02	6.00	2.66	2.50	3.23	4.60	5.00		
3.07	1.28	9.40	8.12	6.00	2.71	2.50	3.29	4.04	5.00		
2.62	1.93	9.80	7.87	6.00	2.49	2.50	3.03	4.20	5.00		
2.92	1.63	9.88	8.25	6.00	2.50	2.50	3.04	4.04	5.00		
3.16	1.41	9.45	8.04	6.00	2.72	2.50	3.31	4.44	5.00		
3.01	1.76	9.35	7.59	6.00	2.57	2.50	3.12	5.00	5.00		
2.83	1.55	9.38	7.83	6.00	2.62	2.50	3.18	3.96	5.00		
2.38	0.90	9.23	8.33	6.00	2.76	2.50	3.35	5.42	5.00		
3.25	1.75	9.28	7.53	6.00	2.65	2.50	3.22	4.62	5.00		
3.02	1.76	9.25	7.49	6.00	2.55	2.50	3.10	4.80	5.00		
1.98	0.87	8.00	7.13	6.00	2.50	2.50	3.04	5.86	5.00		
2.87	2.06	9.13	7.07	6.00	2.29	2.50	2.78	4.84	5.00		
2.16	1.06	8.30	7.24	6.00	3.52	2.50	4.28	5.10	5.00		
1.81	0.81	7.80	6.99	6.00	2.65	2.50	3.22	5.34	5.00		
2.43	0.65	8.13	7.48	6.00	2.54	2.50	3.09	5.16	5.00		
1.96	1.14	8.35	7.21	6.00	2.75	2.50	3.34	5.25	5.00		
2.49	1.38	9.06	7.67	6.00	2.69	2.50	3.27	4.90	5.00	$20.73	$18.42

COMPLETE

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	Phosphoric Acid—Water soluble Found %
Swift's Fertilizer Works, Atlanta, Ga.			
Swift's Cotton King High Grade Guano	3427	1	6.03
Swift's Cotton Plant Standard-Grade Guano...	2800	1	6.00
	2935	1	5.30
	3447	7	5.33
	3813	1	4.40
Average		10	5.26
Swift's Golden Harvest Standard High-Grade Guano	2938	2	5.88
Swift's Red Steer Standard-Grade Guano......	2229	2	3.40
	2280	2	5.63
	2580	1	5.30
	2643	1	5.13
	2802	1	5.50
	2939	2	5.13
	3146	1	5.15
	3379	2	4.83
	3498	4	4.25
	3766	1	5.33
	3821	1	4.85
	4005	2	4.80
	4232	1	3.80
Average		21	4.85
Virginia-Carolina Chemical Co., Jackson, Miss.			
Royal Animal Bone Guano.....................	3472	1	7.63
Royal Blood, Bone and Potash	3947	1	7.78
Royal Cotton Boll Guano	3470	1	6.05
Royal High-Grade Guano	3314	1	8.13
	4389	1	7.73
Average		2	7.93
Scott's Gossypium Phospho....................	3431	2	7.15
	3816	1	7.78
	3945	1	7.30

FERTILIZERS.

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
			Available								
Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Foun %	Guarant'd %		Found %	Guarant'd %	Found	Guarant'd
3.98	1.22	11.23	10.01	9.00	1.90	2.47	2.31	2.32	2.00	$18.65	$19.13
3.90	1.18	11.08	9.90	9.00	1.68	1.65	2.04	1.42	1.00		
3.94	1.51	10.75	9.24	9.00	1.72	1.65	2.09	1.32	1.00		
4.16	1.56	11.05	9.49	9.00	1.59	1.65	1.93	1.48	1.00		
5.85	1.58	11.83	10.25	9.00	1.75	1.65	2.13	1.20	1.00		
4.46	1.46	11.18	9.72	9.00	1.69	1.65	2.05	1.36	1.00	$16.90	$15.71
3.05	1.27	10.20	8.93	8.00	1.62	1.65	1.97	1.62	2.00	$16.04	$15.44
5.45	1.63	10.48	8.85	8.00	1.72	1.65	2.09	2.08	2.00		
4.07	1.38	11.08	9.70	8.00	1.69	1.65	2.05	2.32	2.00		
3.13	1.72	10.15	8.43	8.00	1.65	1.65	2.01	1.60	2.00		
3.49	1.31	9.93	8.62	8.00	1.65	1.65	2.01	2.10	2.00		
3.69	1.16	10.35	9.19	8.00	1.65	1.65	2.01	1.68	2.00		
3.12	1.25	9.50	8.25	8.00	1.58	1.65	1.92	2.00	2.00		
2.94	1.21	9.30	8.09	8.00	1.90	1.65	2.31	2.00	2.00		
3.89	1.08	9.80	8.72	8.00	1.73	1.65	2.10	2.82	2.00		
4.70	1.48	10.43	8.95	8.00	1.78	1.65	2.16	2.00	2.00		
1.58	0.72	7.63	6.91	8.00	1.45	1.65	1.76	2.80	2.00		
4.68	0.87	10.40	9.53	8.00	1.57	1.65	1.91	1.84	2.00		
3.50	1.10	9.40	8.30	8.00	1.65	1.65	2.01	2.54	2.00		
4.58	0.65	9.03	8.38	8.00	1.70	1.65	2.07	1.98	2.00		
3.76	1.20	9.81	8.61	8.00	1.67	1.65	2.03	2.14	2.00	$16.27	$15.44
3.82	1.25	12.70	11.45	9.00	1.37	1 65	1.67	1.62	1.00	$17.93	$15.71
4.14	0.98	12.90	11.92	10.00	1.00	1.65	1.22	1.76	1.50	$17.36	$17.18
3.87	1.06	10.98	9.92	8.00	1.96	1.65	2.38	2.00	2.00	$18.49	$15.44
3.62	1.38	13.13	11.75	10.00	1.08	1.65	1.31	1.86	1.50		
3.89	1.56	13.18	11.62	10.00	0.95	1.65	1.16	1.16	1.50		
3.76	1.47	13.16	11.69	10.00	1.02	1.65	1.24	1.51	1.50	$16.98	$17.18
3.03	1.15	11.33	10.18	10.00	2.33	1.65	2.83	1.26	1.50		
2.77	0.90	11.45	10.55	10.00	1.89	1.65	2.30	2.24	1.50		
3.37	0.63	11.30	10.67	10.00	1.69	1.65	2.05	1.94	1.50		

			COMPLETE
Manufacturer or Jobber and Brand	Station Number	Number of samples composited	Phosphoric Acid—Water soluble Found %
Virginia-Carolina Chemical Co.—Continued.			
	4052	2	7.40
Average		6	7.41
Virginia-Carolina Chemical Co., Memphis, Tenn.			
Hope Cotton Grower	3220	1	6.03
Mobile Double-Eagle Guano	3223	2	7.50
	3467	1	7.83
	3545	1	8.08
	3659	1	7.75
Average		5	7.79
Mobile Standard Guano	2885	1	7.53
Royal Blood, Bone and Potash	3809	1	7.40
	3975	1	7.28
Average		2	7.34
Royal Cotton Boll Guano	3810	1	5.85
Royal Fruit Grower	3660	1	6.25
Scott's Gossypium Phospho	3256	9	8.03
	3544	1	7.30
	3668	2	8.25
	3761	1	8.38
	3888	1	7.25
	4001	2	8.08
	4181	1	7.43
Average		17	7.82
Scott's State Standard Guano	3251	2	6.13
	3662	1	5.93
	3769	2	5.18
Average		5	5.75
Virginia-Carolina High-Grade Top Dresser	3173	3	7.50
	3466	1	3.68
Average		4	5.59
Virginia-Carolina Rice Special	3661	1	3.58

FERTILIZERS.

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
			Available								
Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found %	Guarant'd %		Found %	Guarant'd %	Found	Guarant'd
3.04	0.91	11.35	10.44	10.00	1.75	1.65	2.13	1.70	1.50		
3.05	0.90	11.36	10.46	10.00	1.92	1.65	2.33	1.79	1.50	$18.77	$17.18
2.83	1.21	10.07	8.86	8.00	1.65	1.65	2.01	2.06	2.00	$16.41	$15.44
2.84	1.06	11.40	10.34	10.00	1.48	1.65	1.80	2.02	1.50		
2.89	1.83	12.55	10.72	10.00	1.74	1.65	2.11	2.06	1.50		
3.37	0.88	12.33	11.54	10.00	1.23	1.65	1.49	2.36	1.50		
3.38	1.02	12.15	11.13	10.00	1.55	1.65	1.88	1.74	1.50		
3.12	1.20	12.11	10.91	10.00	1.50	1.65	1.82	2.05	1.50	$18.11	$17.18
4.26	1.31	13.10	11.79	8.00	1.65	1.65	2.01	1.66	2.00	$19.22	$15.44
2.79	1.14	11.33	10.19	10.00	1.67	1.65	2.03	1.70	1.50		
3.01	1.61	11.90	10.29	10.00	1.90	1.65	2.31	2.32	1.50		
2.90	1.38	11.62	10.24	10.00	1.79	1.65	2.17	2.01	1.50	$18.29	$17.18
2.40	1.15	9.40	8.25	8.00	2.26	1.65	2.75	2.00	2.00	$17.66	$15.44
2.53	1.10	9.88	8.78	8.00	1.67	2.47	2.03	4.80	5.00	$18.58	$20.46
2.08	1.42	11.53	10.11	10.00	1.56	1.65	1.90	1.58	1.50		
3.55	0.95	11.80	10.85	10.00	1.65	1.65	2.01	1.86	1.50		
3.02	1.16	12.43	11.27	10.00	1.47	1.65	1.79	1.80	1.50		
3.09	1.26	12.73	11.47	10.00	1.40	1.65	1.70	1.74	1.50		
2.35	1.45	11.05	9.60	10.00	1.44	1.65	1.75	2.50	1.50		
2.46	1.21	11.75	10.54	10.00	1.40	1.65	1.70	2.18	1.50		
3.12	1.15	11.70	10.55	10.00	1.93	1.65	2.35	1.74	1.50		
2.81	1.23	11.86	10.63	10.00	1.55	1.65	1.89	1.91	1.50	$17.86	$17.18
2.06	1.44	9.63	8.19	8.00	1.65	1.65	2.01	2.26	2.00		
2.30	1.07	9.30	8.23	8.00	1.72	1.65	2.09	2.06	2.00		
2.64	0.81	8.63	7.82	8.00	1.39	1.65	1.69	2.38	2.00		
2.33	1.11	9.19	8.08	8.00	1.59	1.65	1.93	2.23	2.00	$15.52	$15.44
3.00	1.78	12.28	10.50	4.00	2.08	6.17	2.53	4.26	2.50		
2.01	0.86	6.55	5.69	4.00	3.88	6.17	4.72	2.80	2.50		
2.51	1.32	9.42	8.10	4.00	2.98	6.17	3.63	3.53	2.50	$21.03	$26.02
6.42	1.77	11.77	10.00	10.00	1.82	1.65	2.21	1.72	2.00	$17.90	$17.58

COMPLETE

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	Phosphoric Acid—Water soluble Found %
Virginia-Carolina Chemical Co., Mobile, Ala.			
Mobile Double-Eagle Guano	3066	1	7.45
	3300	1	5.75
	3696	1	7.30
	3863	1	8.18
	3978	1	7.60
	4113	1	7.83
Average		6	7.35
Mobile Raw Bone Superphosphate	3697	1	6.58
Royal Blood, Bone and Potash	3301	1	2.20
	4112	1	6.28
Average		2	4.24
Royal High-Grade Guano	3006	1	2.33
	3329	1	2.35
	3885	1	0.70
Average		3	1.79
Royal Vegetable Fertilizer	3245	1	5.55
Scott's Gossypium Phospho	2887	1	8.25
	3393	1	6.93
	3815	1	6.90
Average		3	7.36
Scott's Gossypium Phospho Special	3315	1	6.93
Scott's State Standard Guano	3098	1	5.88
Virginia-Carolina Rice Special	3419	1	3.33
	3476	1	2.93
	3825	1	5.43
	3764	1	4.18
Average		4	3.97
Virginia-Carolina Co.'s Truck Grower	3488	1	5.65

FERTILIZERS.

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
			Available								
Reverted Found %	Insoluble Found %	Total Found	Found %	Guarant'd %	Found %	Guarant'd %		Found %	Guarant'd %	Found	Guarant'd
5.90	1.83	15.18	13.35	10.00	1.65	1.65	2.01	1.72	1.50		
5.56	1.57	12.88	11.31	10.00	1.65	1.65	2.01	2.46	1.50		
2.28	1.60	11.18	9.58	10.00	1.75	1.65	2.13	2.02	1.50		
3.00	1.25	12.43	11.18	10.00	1.49	1.65	1.81	2.24	1.50		
2.97	1.41	11.98	10.57	10.00	1.78	1.65	2.16	2.30	1.50		
3.47	1.35	12.65	11.30	10.00	1.65	1.65	2.01	1.50	1.50		
3.86	1.50	12.72	11.22	10.00	1.66	1.65	2.02	2.04	1.50	$18.95	$17.18
3.09	2.76	12.43	9.67	10.00	1.69	1.65	2.05	1.50	1.50	$16.95	$17.18
7.32	3.11	12.63	9.52	10.00	1.69	1.65	2.05	1.52	1.50		
5.23	1.34	12.85	11.51	10.00	1.73	1.65	2.10	1.58	1.50		
6.28	2.23	12.74	10.52	10.00	1.71	1.65	2.08	1.55	1.50	$17.97	$17.18
7.70	2.50	12.53	10.03	10.00	1.65	1.65	2.01	1.52	1.50		
7.36	2.84	12.55	9.71	10.00	1.72	1.65	2.09	1.66	1.50		
8.58	2.40	11.68	9.28	10.00	1.98	1.65	2.41	1.90	1.50		
7.88	2.58	12.25	9.67	10.00	1.78	1.65	2.17	1.69	1.50	$17.39	$17.18
3.75	1.78	11.08	9.30	8.00	3.09	2.47	3.76	5.42	4.00	$24.18	$19.66
4.63	1.37	14.25	12.88	10.00	1.65	1.65	2.01	2.12	1.50		
4.26	1.41	12.60	11.19	10.00	1.74	1.65	2.11	1.64	1.50		
3.68	1.52	12.10	10.58	10.00	1.52	1.65	1.85	1.62	1.50		
4.19	1.43	12.98	11.55	10.00	1.64	1.65	1.99	1.79	1.50	$19.04	$17.18
3.49	2.38	12.80	10.42	10.00	1.65	1.65	2.01	1.84	2.00	$17.90	$17.58
3.47	1.88	11.23	9.35	8.00	1.89	1.65	2.30	2.46	2.00	$18.02	$15.44
6.73	2.72	12.78	10.06	10.00	1.65	1.65	2.01	1.88	2.00		
6.70	2.90	12.53	9.63	10.00	1.65	1.65	2.01	2.00	2.00		
3.86	1.14	10.43	9.29	10.00	1.34	1.65	1.65	2.26	2.00		
4.22	1.40	9.80	8.40	10.00	1.89	1.65	2.30	2.40	2.00		
5.38	2.04	11.39	9.35	10.00	1.63	1.65	1.99	2.14	2.00	$16.93	$17.58
4.16	1.04	10.85	9.81	8.00	2.20	2.06	2.67	2.66	6.00	$19.67	$19.95

COMPLETE

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	Phosphoric Acid—Water soluble Found %
Virginia-Carolina Chemical Co., Shreveport, La.			
Eureka Complete Fertilizer	3352	1	7.55
	3638	1	6.93
Average		2	7.24
Mobile Double-Eagle Guano	2244	1	8.63
	2504	1	8.28
	2529	1	7.65
	2617	1	8.13
	2642	1	7.88
	2679	1	8.10
	2716	1	7.38
	2765	2	8.05
	2828	3	8.13
	2926	2	8.00
	3031	4	7.95
	3121	3	7.13
	3291	7	6.60
	3450	6	7.68
	3468	9	7.70
	3571	10	8.35
	3706	4	5.98
	3880	5	6.50
	3953	1	9.50
	4037	1	9.65
	4377	1	7.15
Average		65	7.83
Mobile Raw Bone Ammoniated Superphosphate	2243	1	5.73
	2656	1	7.65
	2801	1	7.98
	2883	2	8.03
	2940	2	8.28
	3350	1	8.10
	3663	1	7.68
	3722	1	7.05
	3819	1	7.45
	4051	2	7.53
Average		13	7.55
Mobile Standard Guano	2618	1	8.40
	2934	1	7.70
	3417	1	6.88
Average		3	7.66

FERTILIZERS.

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
			Available								
Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found %	Guarant'd %		Found %	Guarant'd %	Found	Guarant'd
3.15	1.78	12.48	10.70	10.00	1.57	1.65	1.91	3.32	4.00		
3.07	2.00	12.00	10.00	10.00	1.77	1.65	2.15	6.72	4.00		
3.11	1.89	12.24	10.35	10.00	1.67	1.65	2.03	5.02	4.00	$20.43	$19.18
3.29	1.43	13.35	11.92	10.00	1.65	1.65	2.00	0.54	1.50		
3.17	1.43	12.88	11.45	10.00	1 83	1.65	2.22	2.32	1.50		
4.33	0.80	12.78	11.98	10.00	1.99	1.65	2.42	1.76	1.50		
3.02	1.78	12.93	11.15	10.00	2.05	1.65	2.49	1.92	1.50		
3.37	1.68	12.93	11.25	10.00	1.81	1.65	2.20	1.66	1.50		
3.37	1.46	12.93	11.47	10.00	1.93	1.65	2.35	1.98	1.50		
2.90	1.80	12.08	10.20	10.00	1.87	1.65	2.27	2.20	1.50		
2.73	1.75	12.53	10.78	10.00	2.03	1.65	2.46	1.64	1.50		
3.20	1.67	13.00	11.33	10.00	1.86	1.65	2.26	1.54	1.50		
3.52	1.58	13.10	11.52	10 00	1.93	1.65	2.35	1.50	1.50		
3.12	1.53	12.60	11.07	10.00	1.84	1.65	2.23	1.74	1.50		
3.28	1.22	11.63	10.41	10.00	1.68	1.65	2.04	2.48	1.50		
3.19	1.86	11.65	9.79	10.00	1.71	1 65	2.08	2.26	1.50		
3.00	1.40	12.08	10.68	10.00	1.65	1.65	2.01	2.60	1.50		
3.25	1.33	12.28	10.95	10.00	1.79	1.65	2.18	1.66	1.50		
3.49	1.21	13.05	11.84	10.00	1.60	1.65	1.94	2.40	1.50		
4.21	1.11	11.30	10.19	10.00	1.99	1.65	2.42	1.64	1.50		
5.08	0.47	12.05	11.58	10.00	2.08	1.65	2.53	1.98	1.50		
5.90	0.63	16.03	15.40	10.00	1.33	1.65	1.62	1.52	1.50		
5.47	0.66	15.78	15.12	10.00	1.30	1.65	1.58	1.64	1.50		
5.19	0.26	12.60	12.34	10.00	1.66	1.65	2.02	1.50	1.50		
3.72	1.29	12.84	11.54	10.00	1.79	1.65	2.17	1.83	1.50	$19.54	$17 18
4.89	3.18	13.80	10.62	10.00	1.65	1.65	2.00	0.86	1.50		
3.13	2.17	12.95	10.78	10.00	1.70	1.65	2.07	1.82	1.50		
3.99	2.11	14.08	11.97	10.00	1.74	1.65	2.11	2.34	1.50		
3.49	1.58	13.10	11.52	10.00	1.77	1.65	2.15	1.96	1.50		
4.14	2.46	14.88	12.42	10.00	1.95	1.65	2.37	2.02	1.50		
3.50	2.38	13.98	11.60	10.00	0.91	1.65	1.11	0.94	1.50		
4.13	2.32	14.13	11.81	10.00	1.96	1.65	2.38	2.36	1.50		
4.26	0.54	11.85	11.31	10.00	2.19	1.65	2.66	1.86	1.50		
4.82	0.61	12.88	12.27	10.00	1.85	1.65	2.25	2.00	1.50		
4.97	1.28	13.78	12.50	10.00	1.88	1.65	2.28	2.00	1.50		
4.13	1.86	13.54	11.68	10.00	1.76	1.65	2.14	1.82	1.50	$19.59	$17.18
3.47	2.93	14.80	11.87	8.00	2.01	1.65	2.44	2.26	2.00		
2.93	1.45	12.08	10.63	8.00	1.68	1.65	2.04	2.00	2.00		
3.56	1.61	12.05	10.44	8.00	1.43	1.65	1 74	2.04	2.00		
3.32	2.00	12.98	10.98	8.00	1.71	1.65	2.07	2.10	2.00	$18.90	$15.44

COMPLETE

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	Phosphoric Acid—Water soluble Found %
Virginia-Carolina Chemical Co.—Continued.			
Royal Animal Bone Guano	3351	1	8.35
Royal Blood, Bone and Potash	2640	2	8.23
	2867	1	8.02
	2925	2	8.13
	3152	5	8.40
	3290	7	6.83
	3430	3	7.70
	3566	5	7.95
	3733	1	7.18
	′034	1	7.30
Average		27	7.75
Royal Cotton Boll Guano	2503	1	8.70
	2619	1	8.55
	2718	1	8.00
	2803	1	6.70
	2944	2	8.20
	3244	1	7.63
	3362	3	7.30
	3481	4	7.53
	3651	2	5.95
	3757	1	6.75
	3818	1	5.20
	4192	1	6.15
Average		19	7.22
Royal Fruit Grower	2491	2	7.75
	4114	1	5.35
Average		3	6.55
Royal High Grade Guano	2993	2	8.20
	3092	1	7.93
	3360	3	7.53
	3547	1	7.18
Average		7	7.71
Virginia-Carolina Cane Grower	3814	1	2.88

FERTILIZERS.

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
			Available								
Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found %	Guarant'd %		Found %	Guarant'd %	Found	Guarant'd
3.07	1.68	13.10	11.42	9.00	0.93	1.65	1.13	1.84	1.00	$16.67	$15.71
3.86	2.51	14.60	12.09	10.00	1.93	1.65	2.35	2.58	1.50		
4.40	2.31	14.73	12.42	10.00	2.11	1.65	2.56	2.56	1.50		
3.37	1.60	13.10	11.50	10.00	1.47	1.65	1.79	1.64	1.50		
3.47	1.76	13.63	11.87	10.00	1.80	1.65	2.19	1.92	1.50		
3.90	2.30	13.03	10.73	10.00	1.90	1.65	2.31	2.22	1.50		
3.68	1.85	13.23	11.38	10.00	2.01	1.65	2.44	2.32	1.50		
3.13	2.05	13.13	11.08	10.00	1.74	1.65	2.11	3.52	1.50		
4.83	0.69	12.70	12.01	10.00	1.79	1 65	2.18	1.52	1.50		
4.92	0.46	12.68	12.22	10.00	1.82	1.65	2.21	1.70	1.50		
3.95	1.73	13.43	11.70	10.00	1.84	1.65	2.24	2.22	1.50	$20.18	$17.18
3.46	2.32	14.48	12.16	8.00	1.72	1.65	2.09	2.68	2.00		
3.50	2.80	14.85	12.05	8.00	1.87	1.65	2.27	2.60	2.00		
3.88	2.65	14.53	11.88	8.00	2.12	1.65	2.58	2.50	2.00		
3.48	1.20	11.38	10.18	8.00	1.90	1.65	2.31	2.10	2.00		
3.86	2.62	14.68	12.06	8.00	2.02	1.65	2.45	2.88	2.00		
2.87	1.50	12.00	10.50	8.00	1.38	1 65	1.68	1.60	2.00		
3.87	1.96	13.13	11.17	8.00	1.89	1.65	2.30	2.78	2.00		
3.77	2.25	13.55	11.30	8.00	1.90	1.65	2.31	2.81	2.00		
3.72	1.11	10.78	9.67	8.00	1.64	1.65	1.99	2.00	2.00		
3.12	1.51	11.38	9.87	8.00	1.41	1.65	1.71	2.80	2.00		
4.04	0.46	9.70	9.24	8.00	2.14	1.65	2.60	2.50	2.00		
4.90	0.65	11.70	11.05	8.00	1.65	1.65	2.01	2.41	2.00		
3.71	1.75	12.68	10.93	8.00	1.80	1.65	2.20	2.48	2.00	$19.44	$15.44
3.51	2.67	13.93	11.26	8.00	2.26	2.47	2.75	5.00	5.00		
3.73	0.80	9.88	9.08	8.00	2.05	2.47	2.49	4.40	5.00		
3.62	1.74	11.91	10.17	8.00	2.16	2.47	2.62	4.70	5.00	$21.55	$20 46
3.93	2.60	14.73	12.13	10.00	2.02	1.65	2.45	2.70	1.50		
3.33	1.54	12.80	11.26	10 00	1.84	1.65	2.24	2.08	1.50		
3.74	2.13	13.40	11.27	10.00	1.41	1.65	1.71	2.64	1.50		
2.99	1.56	11.73	10.17	10.00	1.30	1.65	1.58	2.06	1.50		
3.50	1.96	13.17	11.21	10.00	1.64	1.65	2.00	2.37	1.50	$19.14	$17.18
3.80	0.22	6.90	6.68	5.00	4.94	4.94	6.00	1.28	1.00	$23.98	$21.96

COMPLETE

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	Phosphoric Acid—Water soluble Found %
Virginia-Carolina Chemical Co.—Continued.			
Royal Vegetable Fertilizer	2373	1	5.35
	2717	1	6.53
	2760	4	6.98
	2829	3	7.38
	2882	3	7.68
	2924	3	8.08
	3097	2	6.80
	3218	3	5.83
	3292	3	7.65
	3459	2	7.80
	3557	2	7.80
	4191	1	5.75
Average		28	6.97
Scott's Gossypium Phospho	2370	1	7.23
	2446	1	7.88
	2523	2	7.88
	2562	2	8.13
	2616	1	8.05
	2678	1	8.03
	2713	1	7.85
	2767	2	7.85
	2827	3	8.18
	2921	8	7.18
	2999	5	7.60
	3055	5	7.60
	3117	7	7.88
	3187	19	7.55
	3289	19	6.58
	3382	9	7.63
	3482	14	7.53
	3654	5	8.38
	3730	10	7.00
	3869	8	6.33
	4053	4	6.43
	4196	2	8.25
	4330	2	7.48
	4402	1	6.50
Average		132	7.56
Scott's Ammoniated Bone	2977	1	6.33
	3150	4	6.43
	3560	4	7.60
	3822	1	4.95
	4130	1	7.70
Average		11	6.60

FERTILIZERS.

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
			Available								
Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found %	Guarant'd %		Found %	Guarant'd %	Found	Guarant'd
4.41	2.27	12.03	9.76	8.00	2.83	2.47	3.44	2.76	4.00		
2.73	1.82	11.08	9.26	8.00	1.62	2.47	1.97	9.22	4.00		
3.08	3.12	13.18	10.06	8.00	2.25	2.47	2.73	5.48	4.00		
3.19	2.88	13.45	10.57	8.00	2.35	2.47	2.85	5.36	4.00		
3.08	1.96	12.72	10.76	8.00	2.23	2.47	2.71	6.60	4.00		
3.56	2.41	14.05	11.64	8.00	2.47	2.47	3.00	4.44	4.00		
2.85	1.55	11.20	9.65	8.00	1.94	2.47	2.36	6.93	4.00		
3.25	1.75	10.83	9.08	8.00	2.47	2.47	3.00	4.00	4.00		
3.36	2.27	13.28	11.01	8.00	2.33	2.47	2.83	5.38	4.00		
3.39	2.16	13.35	11.19	8.00	2.19	2.47	2.66	5.26	4.00		
3.20	2.30	13.30	11.00	8.00	2.40	2.47	2.92	4.58	4.00		
4.78	0.50	11.03	10.53	8.00	2.47	2.47	3.00	3.60	4.00		
3.41	2.08	12.46	10.38	8.00	2.30	2.47	2.79	5.30	4.00	$22.71	$19.66
5.64	0.46	13.33	12.87	10.00	1.65	1.65	2.00	2.52	1.50		
3.34	1.38	12.60	11.22	10.00	1.82	1.65	2.21	1.37	1.50		
3.08	1.77	12.73	10.96	10.00	1.83	1.65	2.22	2.14	1.50		
3.14	1.43	12.70	11.27	10.00	1.84	1.65	2.24	0.78	1.50		
3.40	1.73	13.18	11.45	10.00	1.93	1.65	2.35	1.50	1.50		
3.37	1.58	12.98	11.40	10.00	1.96	1.65	2.38	2.46	1.50		
2.57	1.61	12.03	10.42	10.00	1.78	1.65	2.16	1.50	1.50		
2.92	1.78	12.55	10.77	10.00	2.00	1.65	2.43	1.52	1.50		
3.33	1.57	13.08	11.51	10.00	1.93	1.65	2.35	1.76	1.50		
3.14	1.91	12.23	10.32	10.00	1.70	1.65	2.07	2.10	1.50		
3.51	1.57	12.68	11.11	10.00	2.36	1.65	2.87	2.20	1.50		
3.81	1.62	13.03	11.41	10.00	1.82	1.65	2.21	2.00	1.50		
3.63	1.37	12.88	11.51	10.00	1.84	1.65	2.24	1.44	1.50		
2.93	1.60	12.08	10.48	10.00	1.70	1.65	2.07	1.50	1.50		
3.22	1.93	11.73	9.80	10.00	1.65	1.65	2.01	1.98	1.50		
3.07	1.70	12.40	10.70	10.00	1.45	1.65	1.76	1.84	1.50		
3.40	1.45	12.38	10.93	10.00	1.43	1.65	1.74	2.22	1.50		
4.68	0.91	13.97	13.06	10.00	1.32	1.65	1.60	1.60	1.50		
4.77	1.11	12.88	11.77	10.00	1.76	1.65	2.14	2.02	1.50		
5.28	0.37	11.98	11.61	10.00	1.96	1.65	2.38	1.96	1.50		
5.45	0.57	12.45	11.88	10.00	1.92	1.65	2.33	1.90	1.50		
4.98	0.70	13.93	13.23	10.00	1.27	1.65	1.54	2.28	1.50		
4.52	0.50	12.50	12.00	10.00	1.40	1.65	1.70	2.12	1.50		
3.48	1.67	11.65	9.98	10.00	1.77	1.65	2.15	1.86	1.50		
3.78	1.35	12.66	11.32	10.00	1.75	1.65	2.13	1.86	1.50	$19.20	$17.18
3.09	0.81	10.23	9.42	9.00	1.88	1.65	2.28	3.04	1.00		
2.87	0.98	10.28	9.30	9.00	1.77	1.65	2.15	2.28	1.00		
2.97	2.28	12.85	10.57	9.00	1.52	1.65	1.85	2.50	1.00		
3.36	1.72	10.03	8.31	9.00	1.90	1.65	2.31	1.70	1.00		
4.68	1.79	14.17	12.38	9.00	0.17	1.65	0.21	1.72	1.00		
3.30	1.52	11.51	10.00	9.00	1.45	1.65	1.76	2.25	1.00	$17.14	$15.71

COMPLETE

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	Phosphoric Acid—Water soluble Found %
Virginia-Carolina Chemical Co.—Continued.			
Scott's Gossypium Phospho Special	2835	1	7.80
	3229	2	7.43
	3416	1	8.20
	3546	1	7.65
Average		5	7.77
Scott's Meal Formula	2994	2	5.90
	3093	1	5.95
	3246	1	5.95
	3353	1	6.43
	3553	2	6.43
Average		7	6.13
Scott's State Standard Guano	2502	1	6.48
	2522	2	6.45
	2573	1	6.60
	2719	1	6.48
	2766	2	6.25
	2832	2	6.15
	2912	7	6.60
	3051	1	6.43
	3095	2	6.33
	3184	8	6.75
	3259	3	7.43
	3361	6	5.98
	3432	3	5.73
	3672	7	4.65
	3723	1	5.80
	4032	1	6.05
Average		48	6.25
Virginia-Carolina Chemical Co.'s Truck Grower	2525	2	7.20
	2576	1	7.45
	2620	1	7.50
	2706	2	7.40
	2804	4	7.50
	2943	2	7.45
	3050	1	7.40
	3231	2	7.35
	3363	3	5.75
	3558	2	7.25
Average		20	7.23

FERTILIZERS.

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
			Available								
Reverted Found ½	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found %	Guarant'd %		Found %	Guarant'd %	Found	Guarant'd
3.21	1.67	12.68	11.01	10.00	1.80	1.65	2.19	2.22	2.00		
3.39	0.93	11.75	10.82	10.00	1.88	1.65	2.28	1.76	2.00		
3.18	1.42	12.80	11.38	10.00	1.47	1.65	1.79	2.06	2.00		
4.77	0.46	12.88	12.42	10.00	1.37	1.65	1.67	2.38	2.00		
3.64	1.12	12.53	11.41	10.00	1.63	1.65	1.98	2.11	2.00	$19.11	$17.58
3.19	0.84	9.93	9.09	9.00	1.77	1.65	2.15	2.66	1.00		
3.02	0.83	9.80	8.97	9.00	1.90	1.65	2.31	2.36	1.00		
2.33	1.52	9.80	8.28	9.00	1.45	1.65	1.76	2.42	1.00		
2.75	2.52	11.70	9.18	9.00	1.14	1.65	1.39	1.72	1.00		
2.38	1.07	9.88	8.81	9.00	1.56	1.65	1.90	1.60	1.00		
2.73	1.36	10.22	8.87	9.00	1.56	1.65	1.90	2.15	1.00	$16.20	$15.71
2.84	0.98	10.30	9.32	8.00	1.90	1.65	2.31	2.48	2.00		
2.47	1.58	10.50	8.92	8.00	1.77	1.65	2.15	2.06	2.00		
3.10	1.00	10.70	9.70	8 00	1.89	1.65	2.30	2.00	2.00		
2.95	1.27	10.70	9.43	8 00	1.91	1.65	2.32	2.22	2.00		
2.78	1.10	10.13	9.03	8.00	1.86	1.65	2.26	2.34	2.00		
3.00	1.10	10.25	9.15	8.00	1.65	1.65	2.01	2.38	2.00		
3.35	0.95	10.90	9.95	8.00	1.97	1.65	2.39	2.66	2.00		
3.36	1.16	10.95	9.79	8.00	2.37	1.65	2.88	2.50	2.00		
3.04	0.93	10.30	9.37	8.00	1.90	1.65	2.31	2.54	2.00		
2.51	1.37	10.63	9.26	8.00	1.83	1.65	2.22	2.60	2.00		
2.42	0.98	10.83	9.85	8.00	1.56	1.65	1.90	2.30	2.00		
3.11	1.71	10.80	9.09	8.00	1.46	1.65	1.77	2.20	2.00		
3.22	1.23	10.18	8.95	8.00	2.20	1.65	2.67	2.34	2.00		
3.67	1.41	9.73	8.32	8.00	1.68	1.65	2.04	3.64	2.00		
4.70	0.58	11.08	10.50	8.00	1.54	1.65	1.87	2.20	2.00		
4.63	0.42	11.10	10.68	8.00	1.67	1.65	2.03	2.00	2.00		
3.20	1.11	10.57	9.46	8.00	1.82	1.65	2.21	2.40	2.00	$17.87	$15.44
2.93	2.35	12.48	10.13	8.00	2.06	2.06	2.50	6.42	6.00		
2.55	2.83	12.83	10.00	8.00	2.06	2.06	2.50	7.12	6.00		
2.54	2.76	12.80	10.04	8.00	1.96	2.06	2.38	7.02	6.00		
2.98	2.15	12.53	10.38	8.00	1.84	2.06	2.24	6.04	6.00		
3.68	1.97	13.15	11.18	8.00	1.72	2.06	2.09	6.66	6.00		
3.55	2.28	13.28	11.00	8.00	1.92	2.06	2.33	4.80	6.00		
3.23	2.17	12.80	10.63	8.00	1.94	2.06	2.36	6.14	6.00		
3.10	1.65	12.10	10.45	8.00	2.10	2.06	2.55	5.02	6.00		
2.95	1.60	10.30	8.70	8.00	1.81	2.06	2.20	7.30	6.00		
3.07	2.26	12.58	10.32	8.00	1.79	2.06	2.18	6.92	6.00		
3.05	2.20	12.49	10.28	8.00	1.92	2.06	2.33	6.34	6.00	$22.22	$19.95

COMPLETE

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	Phosphoric Acid—Water soluble Found %
Virginia-Carolina Chemical Co.—Continued.			
Virginia-Carolina Top Dresser	3464	1	4.15
	3465	2	3.73
	3564	5	3.80
	3735	2	3.33
	3835	3	3.50
	4320	1	3.50
Average		14	3.67

PHOSPHORIC ACID AND

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Clinton Cotton Oil and Manufacturing Co., Clinton, La.		
Comos Corn	3005	1
	3099	1
	3428	1
	3551	1
	4007	1
Average		5
New Orleans Acid and Fertilizer Co., Gretna, La.		
Creole Sugar Cane Grower	3542	1
	3656	2
	3726	2
	3785	2
	3877	3
	3992	5
	4102	4
	4135	4
	4154	3
	4211	6
	4241	1
Average		33

FERTILIZERS.

PHOSPHORIC ACID					Nitrogen		Ammonia Found %	POTASH		Comparative Value Per Ton	
			Available								
Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found %	Guarant'd %		Found %	Guarant'd %	Found	Guarant'd
1.75	1.00	6.90	5.90	4.00	5.08	6.17	6.17	2.80	2.50		
2.17	0.90	6.80	5.90	4.00	3.45	6.17	4.19	2.84	2.50		
1.71	0.79	6.30	5.51	4.00	5.72	6.17	6.95	3.12	2.50		
1.73	0.97	6.03	5.06	4.00	5.26	6.17	6.39	2.74	2.50		
2.04	0.71	6.25	5.54	4.00	5.06	6.17	6.15	2.94	2.50		
2.43	0.70	6.63	5.93	4.00	4.50	6.17	5.47	3.08	2.50		
1.97	0.85	6.49	5.64	4.00	4.85	6.17	5.89	2.92	2.50	$23.89	$26.02

NITROGEN FERTILIZERS.

PHOSPHORIC ACID						Nitrogen		Ammonia %	Comparative Value Per Ton	
				Available						
Water soluble Found %	Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found %	Guarant'd %		Found	Guarant'd
5.70	2.67	1.53	9.90	8.37	5.12	3.14	3.00	3.81		
5.83	2.75	1.57	10.15	8.58	5.12	3.39	3.00	4.12		
5.03	3.62	0.20	8.85	8.65	5.12	3.41	3.00	4.14		
5.10	3.58	0.27	8.95	8.68	5.12	3.11	3.00	3.78		
6.28	3.10	1.30	10.68	9.38	5.12	3.01	3.00	3.66		
5.59	3.14	0.97	9.71	8.73	5.12	3.21	3.00	3.90	$19.61	$15.08
5.50	2.34	0.61	8.45	7.84	8.00	3.03	2.50	3.68		
5.30	3.18	0.60	9.08	8.48	8.00	2.35	2.50	2.85		
6.23	3.02	0.65	9.90	9.25	8.00	2.47	2.50	3.00		
5.63	2.85	0.65	9.13	8.48	8.00	2.68	2.50	3.26		
4.23	2.46	0.46	7.15	6.69	8.00	3.53	2.50	4.29		
3.50	2.98	0.47	6.95	6.48	8.00	4.65	2.50	5.65		
5.00	3.48	1.17	9.65	8.48	8.00	2.93	2.50	3.56		
5.10	3.94	0.73	9.77	9.04	8.00	3.15	2.50	3.83		
3.68	3.66	0.61	7.95	7.34	8.00	3.70	2.50	4.50		
3.78	3.19	0.76	7.73	6.97	8.00	3.90	2.50	4.74		
2.35	2.89	0.46	5.70	5.24	8.00	3.70	2.50	4.50		
4.57	3.09	0.65	8.31	7.66	8.00	3.28	2.50	3.99	$18.69	$16.56

PHOSPHORIC ACID AND

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
New Orleans Acid and Fertilizer Co.—Continued.		
Special Sugar Cane Grower No. 67	2724	1
	2808	2
	2894	1
	2982	3
	3224	3
	3376	4
	3499	3
	3675	3
	3695	1
	3727	3
	3784	2
	3876	5
	3993	11
	4107	1
	4134	3
	4155	9
	4214	1
	4236	13
	4310	13
	4349	4
	4354	1
Average		87
Special Sugar Cane Grower No. 106	3377	2
	3550	1
Average		3
Standard Guano and Chemical Manufacturing Co., New Orleans, La.		
Special Formula	2344	2
	2541	2
	2646	1
	2725	5
	2945	8
	3100	1
	3506	2
	3575	13
	3708	5
	3878	5
	3998	3
	4044	8
	4161	2
	4194	2
	4237	5
Average		64

NITROGEN FERTILIZERS.

PHOSPHORIC ACID						Nitrogen		Ammonia Found %	Comparative Value Per Ton	
				Available						
Water soluble Found %	Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found %	Guarant'd %		Found	Guarant'd
5.43	3.59	0.41	9.43	9.02	7.00	5.10	5.00	6.20		
1.68	5.58	0.27	7.53	7.26	7.00	5.18	5.00	6.30		
3.43	5.15	0.75	9.33	8.58	7.00	4.47	5.00	5.43		
1.03	5.64	0.53	7.20	6.67	7.00	5.27	5.00	6.41		
0.93	5.57	0.40	6.90	6.50	7.00	4.39	5.00	5.34		
5.28	2.35	0.42	8.05	7.63	7.00	3.94	5.00	4.79		
5.45	3.26	0.54	9.25	8.71	7.00	4.71	5.00	5.72		
5.23	3.08	0.69	9.00	8.31	7.00	4.61	5.00	5.60		
4.58	1.64	0.16	6.38	6.22	7.00	4.46	5.00	5.42		
5.40	3.18	0.55	9.13	8.58	7.00	4.89	5.00	5.94		
4.15	3.69	0.54	8.38	7.84	7.00	4.25	5.00	5.17		
4.78	2.82	0.55	8.15	7.60	7.00	4.65	5.00	5.65		
5.05	2.97	0.76	8.78	8.02	7.00	5.15	5.00	6.26		
4.00	3.05	0.85	7.90	7.05	7.00	5.68	5.00	6.90		
5.30	3.29	0.96	9.55	8.59	7.00	4.70	5.00	5.70		
4.70	3.29	1.09	9.08	7.99	7.00	4.78	5.00	5.81		
4.93	3.46	1.01	9.40	8.39	7.00	4.50	5.00	5.47		
5.23	3.40	0.82	9.45	8.63	7.00	5.23	5.00	6.36		
4.73	3.80	0.77	9.30	8.53	7.00	4.90	5.00	5.96		
5.70	3.72	0.71	10.13	9.42	7.00	4.73	5.00	5.75		
4.43	4.14	0.48	9.05	8.57	7.00	4.85	5.00	5.89		
4.35	3.65	0.63	8.64	8.01	7.00	4.78	5.00	5.81	$23.87	$23.49
5.08	1.62	0.38	7.08	6.70	6.00	6.64	8.00	8.07		
5.03	1.78	0.52	7.33	6.81	6.00	7.57	8.00	9.20		
5.06	1.70	0.45	7.21	6.76	6.00	7.11	8.00	8.64	$29.99	$32.02
6.30	3.59	1.11	11.00	9.89	8.50	4.79	4.12	5.82		
7.60	2.11	2.07	11.78	9.71	8.50	4.13	4.12	5.02		
7.45	2.10	1.65	11.20	9.55	8.50	4.12	4.12	5.01		
6.45	2.92	1.76	11.13	9.37	8.50	4.52	4.12	5.49		
6.40	3.18	1.62	11.20	9.58	8.50	4.20	4.12	5.10		
5.93	3.34	1.36	10.63	9.27	8.50	4.29	4.12	5.21		
6.00	3.43	1.32	10.75	9.43	8.50	4.60	4.12	5.59		
6.30	3.88	1.20	11.38	10.18	8.50	4.80	4.12	5.83		
5.88	4.07	1.25	11.20	9.95	8.50	4.06	4.12	4.93		
6.03	3.58	1.02	10.63	9.61	8.50	4.20	4.12	5.10		
5.50	3.35	1.18	10.03	8.85	8.50	5.13	4.12	6.24		
5.73	4.07	1.33	11.13	9.80	8.50	4.42	4.12	5.37		
3.50	3.91	2.57	9.98	7.41	8.50	6.65	4.12	8.08		
5.08	4.47	1.70	11.25	9.55	8.50	4.51	4.12	5.48		
6.38	4.34	1.16	11.88	10.72	8.50	4.16	4.12	5.06		
6.04	3.39	1.49	11.01	9.52	8.50	4.57	4.12	5.56	$24.81	$22.28

PHOSPHORIC ACID AND

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Arkansas Fertilizer Co., Little Rock, Ark.		
White Diamond Kali Superphosphate................	3826	1
	3900	1
Average..		2
Gulfport Cotton Oil Fertilizer and Manufacturing Co., Gulfport, Miss.		
Primo High Grade Acid Phosphate and Potash......	3143	1
	3515	1
	3646	1
	3793	1
	3374	1
Average..		5
Primo High Grade Rice Special......................	3420	1
	3511	1
	3648	1
Average..		3
Primo Standard Acid Phosphate and Potash........	3640	1
	3774	1
	4111	1
Average..		3
New Orleans Acid and Fertilizer Co., Gretna, La.		
Dissolved Bone and Potash..........................	2722	1
	2811	1
	2985	3
	3227	4
	3460	3
	3580	7
	3788	2
	3897	3
	4108	1
	4162	1
	4244	1
Average..		27

POTASH FERTILIZERS.

PHOSPHORIC ACID						POTASH		Comparative Value Per Ton	
				Available					
Soluble Found %	Reverted Found %	Insoluble Found %	Total Found %	Found	Guarant'd %	Found %	Guarant'd %	Found	Guarant'd
5.40	7.16	3.52	16.08	12.56	12.00	4.19	2.50		
4.50	5.78	4.72	15.00	10.28	12.00	2.52	2.50		
4.95	6.47	4.12	15.54	11.42	12.00	3.36	2.50	$14.91	$14.84
8.40	3.55	0.40	12.35	11.95	10.00	4.64	4.00		
9.23	3.48	0.77	13.48	12.71	10.00	3.34	4.00		
8.25	3.62	1.01	12.88	11.87	10.00	5.22	4.00		
7.20	2.94	0.59	10.73	10.14	10.00	3.68	4.00		
9.95	3.56	0.87	14.38	13.51	10.00	3.90	4.00		
8.61	3.43	0.73	12.76	12.04	10.00	4.16	4.00	$16.21	$13.90
10.10	4.27	1.01	15.38	14.37	12.00	2.36	2.00		
9.70	3.50	0.78	13.98	13.20	12.00	2.68	2.00		
10.25	4.85	0.95	16.05	15.10	12.00	1.62	2.00		
10.02	4.21	0.91	15.14	14.22	12.00	2.22	2.00	$16.99	$14.44
9.80	3.82	0.96	14.58	13.62	10.00	1.38	2.00		
7.60	3.61	0.59	11.80	11.21	10.00	2.24	2.00		
8.10	3.29	0.51	11.90	11.39	10.00	2.50	2.00		
8.50	3.57	0.69	12.76	12.07	10.00	2.04	2.00	$14.55	$12.30
6.63	6.70	0.47	13.80	13.33	10.00	2.96	2.00		
7.53	4.83	0.77	13.13	12.36	10.00	1.84	2.00		
9.03	2.93	0.75	12.71	11.96	10.00	3.44	2.00		
8.20	2.73	0.25	11.18	10.93	10.00	2.14	2.00		
6.73	3.15	0.52	10.40	9.88	10.00	1.30	2.00		
7.60	3.55	0.18	11.33	11.15	10.00	1.64	2.00		
7.90	4.42	0.06	12.38	12.32	10.00	2.08	2.00		
7.25	3.54	0.34	11.13	10.79	10.00	1.84	2.00		
8.33	2.90	0.17	11.40	11.23	10.00	2.00	2.00		
8.08	4.78	0.19	13.05	12.86	10.00	1.52	2.00		
6.43	5.25	0.70	12.38	11.68	10.00	1.22	2.00		
7.61	4.07	0.40	12.08	11.68	10.00	2.00	2.00	$14.10	$12.30

PHOSPHORIC ACID AND

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Planters' Fertilizer and Chemical Co., New Orleans, La.		
Plantérs' Dissolved Bone and Potash	3295	3
Sonia Cotton Oil Co., Alexandria, La.		
Sonia Early Maturing Cotton Grower	3790	1
Standard Guano and Chemical Manufacturing Co., New Orleans, La.		
Acid Phosphate and Potash	2293	1
	2543	1
	2723	1
	2986	3
	3128	4
	3306	2
	3436	2
	3787	2
	3840	2
	4039	1
	4185	1
	4373	1
Average		21
Dissolved Bone and Potash	3108	1
	3773	1
	3843	1
	4238	2
Average		5
High Grade Acid Phosphate and Potash	2987	4
	3127	7
	3234	2
	3387	2
	3507	3
	3836	2
	3901	1
	4183	1
	4242	1
	4387	1
Average		24

POTASH FERTILIZERS.

PHOSPHORIC ACID						POTASH		Comparative Value Per Ton	
				Available					
Soluble Found %	Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found %	Guarant'd %	Found	Guarant'd
7.25	2.75	1.55	11.55	10.00	10.00	2.00	2.00	$12.30	$12.30
6.48	2.40	1.52	10.40	8.88	10.00	4.62	4.00	$13.20	$13.90
6.90	4.31	1.17	12.38	11.21	10.00	2.72	2.00		
7.33	4.13	5.32	16.78	11.46	10.00	2.00	2.00		
8.33	3.12	3.08	14.53	11.45	10.00	3.40	2.00		
8.80	3.84	3.11	15.75	12.64	10.00	2.74	2.00		
8.13	4.52	3.15	15.80	12.65	10.00	2.44	2.00		
8.85	4.13	3.00	15.98	12.98	10.00	2.36	2.00		
7.83	3.91	4.26	16.00	11.74	10.00	2.00	2.00		
6.43	4.84	4.11	15.38	11.27	10.00	2.08	2.00		
7.35	3.79	4.26	15.40	11.14	10.00	2.52	2.00		
7.93	5.79	3.76	17.48	13.72	10.00	1.68	2.00		
7.65	3.82	3.86	15.33	11.47	10.00	1.58	2.00		
6.00	2.81	0.94	9.75	8.81	10.00	3.54	2.00		
7.63	4.08	3.34	15.05	11.71	10.00	2.42	2.00	$14.47	$12.30
7.48	4.28	3.72	15.48	11.76	10.00	3.76	4.00		
6.58	4.31	4.56	15.45	10.89	10.00	4.00	4.00		
7.63	3.58	3.47	14.68	11.21	10.00	2.38	4.00		
7.65	4.40	1.95	14.00	12.05	10.00	3.62	4.00		
7.34	4.14	3.43	14.90	11.48	10.00	3.44	4.00	$15.04	$13.90
10.00	4.08	2.85	16.93	14.08	12.00	2.72	2.00		
9.13	5.13	3.07	17.33	14.26	12.00	2.26	2.00		
9.45	4.50	2.85	16.80	13.95	12.00	2.14	2.00		
9.50	4.80	2.65	16.95	14.30	12.00	1.90	2.00		
9.55	4.67	2.51	16.73	14.22	12.00	2.20	2.00		
9.00	3.71	3.14	15.85	12.71	12.00	3.06	2.00		
7.50	5.71	3.39	16.60	13.21	12.00	1.50	2.00		
8.20	5.51	2.52	16.03	13.71	12.00	3.90	2.00		
8.60	4.78	1.07	14.45	13.38	12.00	2.32	2.00		
7.95	4.28	1.65	13.88	12.23	12.00	2.01	2.00		
8.89	4.72	2.55	16.16	13.61	12.00	2.40	2.00	$16.48	$14.44

PHOSPHORIC ACID AND

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Swift's Fertilizer Works, Atlanta, Ga.		
Swift's Field and Farm S. G. & P. P.	3514	1
Virginia-Carolina Chemical Co., Memphis, Tenn.		
Hope Potash Acid	3243	1
Royal Compound	3786	2
Royal Potash Compound	3657	1
Scott's Potasso Phospho	3667	3
	3791	1
Average		4
Virginia-Carolina Chemical Co., Mobile, Ala.		
Royal Compound	3045	2
	3313	1
	3453	3
	3665	2
	3864	2
	4275	1
Average		11
Royal Potash Compound	3101	3
	3316	2
	3504	3
	3666	5
	3837	3
	3865	1
	4003	2
	4105	3
	4132	1
	4274	1
Average		24
Scott's Potasso Phospho	3069	1
	3308	5
	3456	10
	3461	1
	3664	3
	3711	9
	3899	4
	3984	1
	4104	4
Average		38

POTASH FERTILIZERS.

PHOSPHORIC ACID						POTASH		Comparative Value Per Ton	
				Available					
Soluble Found %	Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found %	Guarant'd %	Found	Guarant'd
5.08	5.55	1.35	11.98	10.63	10.00	1.72	2.00	$12.75	$12.30
3.63	7.72	2.08	13.43	11.35	10.00	2.52	2.00	$14.16	$12.30
0.80	8.14	2.21	11.15	8.94	10.00	2.30	2.00	$11.41	$12.30
1.40	7.73	2.02	11.15	9.13	10.00	5.88	4.00	$14.47	$13.90
0.49	9.25	4.15	13.89	9.74	12.00	2.86	2.00		
3.90	6.59	2.39	12.88	10.49	12.00	2.16	2.00		
2.20	7.92	3.27	13.39	10.12	12.00	2.51	2.00	$12.84	$14.44
3.48	8.06	2.76	14.30	11.54	10.00	2.12	2.00		
3.40	8.85	1.68	13.93	12.25	10.00	1.58	2.00		
3.65	7.75	2.43	13.83	11.40	10.00	2.00	2.00		
4.75	6.15	1.73	12.63	10.90	10.00	2.16	2.00		
5.00	5.52	1.16	11.68	10.52	10.00	2.24	2.00		
5.08	6.04	2.58	13.70	11.12	10.00	2.38	2.00		
4.23	7.06	2.06	13.35	11.29	10.00	2.08	2.00	$13.74	$12.30
5.43	5.83	1.44	12.70	11.26	10.00	3.64	4.00		
5.30	5.22	2.01	12.53	10.52	10.00	4.26	4.00		
2.23	7.87	2.10	12.20	10.10	10.00	4.38	4.00		
4.45	5.56	1.72	11.73	10.01	10.00	3.44	4.00		
4.90	6.17	1.06	12.13	11.07	10.00	3.76	4.00		
5.63	6.23	0.94	12.80	11.86	10.00	3.28	4.00		
5.53	6.09	0.98	12.60	11.62	10.00	4.04	4.00		
3.88	6.89	1.06	11.83	10.77	10.00	3.10	4.00		
3.43	7.88	0.92	12.23	11.31	10.00	3.10	4.00		
3.43	7.52	2.48	13.43	10.95	10.00	3.10	4.00		
4.42	6.53	1.47	12.42	10.95	10.00	3.61	4.00	$14.60	$13.90
5.00	7.58	1.70	14.28	12.58	12.00	1.65	2.00		
5.75	6.50	2.23	14.48	12.25	12.00	2.00	2.00		
5.25	6.83	2.20	14.28	12.08	12.00	2.26	2.00		
4.18	8.22	2.00	14.40	12.40	12.00	1.60	2.00		
3.68	7.27	2.00	12.95	10.95	12.00	2.06	2.00		
7.38	5.40	1.37	14.15	12.78	12.00	1.82	2.00		
6.08	5.93	1.62	13.63	12.01	12.00	1.54	2.00		
7.15	5.40	1.35	13.90	12.55	12.00	2.60	2.00		
6.88	6.11	1.51	14.50	12.99	12.00	1.48	2.00		
5.71	6.58	1.78	14.06	12.29	12.00	1.89	2.00	$14.66	$14.44

PHOSPHORIC ACID AND

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Virginia-Carolina Chemical Co., Shreveport, La.		
Royal Compound	3068	1
	3232	1
	3512	1
	3838	1
Average		4
Royal Potash Compound	2810	1
	3228	2
	3513	1
	4378	1
Average		5
Scott's Potasso Phospho	3042	2
	3156	7
	3307	5
	3503	6
	3658	1
	3731	5
	3866	1
	4041	1
	4106	1
Average		29

ACID

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Arcadia Cotton Oil Co., Arcadia, La.		
Acid Phosphate	2591	1
	3010	1
	3102	2
	3311	1
	3642	1
	4184	1
Average		7

POTASH FERTILIZERS.

Phosphoric Acid						Potash		Comparative Value Per Ton	
				Available					
Soluble Found %	Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd
7.08	3.25	1.37	11.70	10.33	10.00	3.06	2.00		
8.45	3.19	1.71	13.35	11.64	10.00	2.64	2.00		
7.10	5.55	1.35	14.00	12.65	10.00	1.16	2.00		
6.88	4.91	1.21	13.00	11.79	10.00	2.66	2.00		
7.38	4.23	1.41	13.01	11.60	10.00	2.38	2.00	$14.32	$12.30
7.93	5.97	1.68	15.58	13.90	10.00	1.84	4.00		
7.85	3.70	1.70	13.25	11.55	10.00	2.86	4.00		
3.08	8.77	0.88	12.73	11.85	10.00	9.47	4.00		
6.98	5.09	0.51	12.58	12.07	10.00	8.18	4.00		
6.46	5.88	1.19	13.54	12.34	10.00	5.59	4.00	$17.68	$13.90
12.00	3.56	1.52	17.08	15.56	12.00	2.20	2.00		
10.45	4.19	1.04	15.68	14.64	12.00	3.54	2.00		
8.08	3.39	2.28	13.75	11.47	12.00	2.24	2.00		
8.18	4.09	1.16	13.43	12.27	12.00	2.72	2.00		
6.53	6.95	1.00	14.48	13.48	12.00	3.20	2.00		
5.65	6.71	2.22	14.58	12.36	12.00	1.51	2.00		
6.95	6.99	0.59	14.53	13.94	12.00	2.32	2.00		
5.78	8.18	0.72	14.68	13.96	12.00	5.70	2.00		
7.80	5.02	1.61	14.43	12.82	12.00	2.08	2.00		
7.94	5.45	1.35	14.74	13.39	12 00	2.83	2.00	$16.59	$14.44

PHOSPHATES.

Phosphoric Acid						Comparative Value Per Ton	
				Available			
Soluble Found %	Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found	Guarant'd
8.33	5.71	0.86	14.90	14.04	14.00		
7.40	6.43	0.50	14.33	13.83	14.00		
9.25	5.29	1.64	16.18	14.54	14.00		
9.68	2.71	2.44	14.83	12.39	14.00		
10.58	3.60	1.90	16.08	14.18	14.00		
7.78	6.63	0.42	14.83	14.41	14.00		
8.84	5.06	1.29	15.19	13.90	14.00	$14.87	$14.98

ACID

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Arkansas Fertilizer Co., Little Rock, Ark.		
White Diamond Acid Phosphate	3131	6
	3717	1
Average		7
Caddo Fertilizer Co., Shreveport, La.		
Acid Phosphate	2461	1
	2478	1
	2729	1
	2731	1
	2781	3
	3040	4
	3236	5
	3587	1
	3715	2
	4040	1
Average		20
Capital Fertilizer and Manufacturing Co., Jackson, Miss.		
High-Grade Acid Phosphate	3421	1
	3645	1
	3807	1
	4400	1
Average		4
Standard Acid Phosphate	3375	1
	3719	1
Average		2
Clinton Cotton Oil and Manufacturing Co., Clinton, La.		
Acid Phosphate	3463	1
Continental Fertilizer Co., Nashville, Tenn.		
Acid Phosphate	2459	1
	2548	1
Average		2

PHOSPHATES.

PHOSPHORIC ACID						Comparative Value Per Ton	
				Available			
Soluble Found %	Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found	Guarant'd
8.48	3.83	2.87	15.18	12.31	14.00		
9.93	4.35	1.82	16.10	14.28	14.00		
9.21	4.09	2.35	15.64	13.30	14.00	$14.23	$14.98
10.48	4.70	1.15	16.33	15.18	14.00		
10.85	4.52	1.16	16.53	15.37	14.00		
10.68	5.02	1.43	17.13	15.70	14.00		
10.63	4.95	1.47	17.05	15.58	14.00		
9.93	4.17	1.48	15.58	14.10	14.00		
10.50	6.17	1.21	17.88	16.67	14.00		
8.88	5.19	1.08	15.15	14.07	14.00		
10.60	4.88	0.42	15.90	15.48	14.00		
8.80	5.84	0.86	15.50	14.64	14.00		
8.90	5.07	1.48	15.45	13.97	14.00		
10.03	5.05	1.17	16.25	15.08	14.00	$16.14	$14.98
8.15	4.97	2.48	15.60	13.12	14.00		
10.58	4.17	2.03	16.78	14.75	14.00		
9.35	4.53	0.60	14.48	13.88	14.00		
11.43	4.84	1.77	18.04	16.27	14.00		
9.88	4.63	1.72	16.23	14.51	14.00	$15.53	$14.98
8.10	4.64	2.61	15.35	12.74	12.00		
9.70	4.92	0.38	15.00	14.62	12.00		
8.90	4.78	1.50	15.18	13.68	12.00	$14.64	$12.84
9.10	4.15	2.23	15.48	13.25	12.00	$14.18	$12.84
10.45	4.53	1.35	16.33	14.98	16.00		
10.78	4.35	1.77	16.90	15.13	16.00		
10.62	4.44	1.56	16.62	15.06	16.00	$16.11	$17.12

ACID

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Federal Chemical Co., Nashville, Tenn.		
Daybreak Pure High-Grade Acid Prosphate No. 2..	3390	3
	3586	1
Average		4
Pure High-Grade Acid Phosphate................	3789	1
	3918	3
	4004	3
	4319	1
Average		8
Gulfport Cotton Oil, Fertilizer and Manufacturing Co.,		
Primo High-Grade Acid Phosphate................	2290	1
	2595	1
	2818	1
	3007	1
	3299	4
	3452	3
	3581	3
	3716	1
	3902	1
	3985	1
	4115	1
	4273	1
	4408	1
Average		20
Primo High-Grade Acid Phosphate	3044	6
	3129	4
	3792	1
Average		11
Primo Standard Acid Phosphate..................	2330	1
	3771	2
Average		3

PHOSPHATES.

PHOSPHORIC ACID						Comparative Value Per Ton	
				Available			
Soluble Found %	Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found	Guarant'd
12.65	4.36	0.92	17.93	17.01	16.00		
12.55	4.47	1.26	18.28	17.02	16.00		
12.60	4.42	1.09	18.11	17.02	16.00	$18.21	$17.12
12.70	4.68	1.47	18.85	17.38	14.00		
12.18	1.53	1.92	15.63	13.71	14.00		
10.48	3.54	1.66	15.68	14.02	14.00		
9.80	5.15	1.20	16.15	14.95	14.00		
11.29	3.73	1.56	16.58	15.02	14.00	$16.07	$14.98
13.23	1.88	0.77	15.88	15.11	14.00		
12.38	3.79	1.81	17.98	16.17	14.00		
12.85	3.73	0.92	17.50	16.58	14.00		
10.05	4.82	1.88	16.75	14.87	14.00		
11.03	4.27	0.85	16.15	15.30	14.00		
12.15	3.30	1.63	17.08	15.45	14.00		
12.10	4.31	0.77	17.18	16.41	14.00		
11.80	4.28	0.94	17.02	16.08	14.00		
10.25	2.78	1.22	14.25	13.03	14.00		
10.90	3.55	1.08	15.53	14.45	14.00		
10.00	3.67	0.71	14.38	13.67	14.00		
8.73	6.08	1.87	16.68	14.81	14.00		
10.90	5.37	1.68	17.95	16.27	14.00		
11.26	3.99	1.24	16.49	15.25	14.00	$16.32	$14.98
12.25	3.63	1.70	17.58	15.88	16.00		
12.95	3.27	1.81	18.03	16.22	16.00		
11.63	3.75	0.67	16.05	15.38	16.00		
12.28	3.55	1.39	17.22	15.83	16.00	$16.94	$17.12
10.43	3.86	0.56	14.85	14.29	12.00		
11.25	3.30	1.25	15.80	14.55	12.00		
10.84	3.58	0.91	15.33	14.42	12.00	$15.43	$12.84

		ACID
Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Hazlehurst Oil Mill and Manufacturing Co., Hazlehurst, Miss.		
High-Grade Acid Phosphate	2327	1
	2814	2
	3009	1
Average		4
Jackson Fertilizer Co., Jackson, Miss.		
High-Grade Acid Phosphate	2413	1
	2433	1
	2585	2
	3422	1
	3987	1
	4269	1
	4388	2
Average		9
Meridian Fertilizer Factory, Meridian, Miss.		
Meridian So. Acid Phosphate	2513	1
	2593	1
	2651	1
	2683	1
	2730	1
	2778	5
	2866	1
	3047	5
	3046	2
	3126	7
	3237	4
	3391	4
	3502	7
	3649	4
	3770	3
	3845	1
	3986	1
	4048	2
	2647*	1
Average		52

* This sample was sent here with a guarantee of 1.50 per cent of potash, but only 0.28 per cent potash was found. The sample is evidently an acid phosphate.

PHOSPHATES.

PHOSPHORIC ACID						Comparative Value Per Ton	
				Available			
Soluble Found %	Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found	Guarant'd
11.03	3.12	2.75	16.90	14.15	14.00		
11.33	4.97	0.85	17.15	16.30	14.00		
10.63	4.36	1.66	16.65	14.99	14.00		
11.00	4.15	1.75	16.90	15.15	14.00	$16.21	$14.98
11.90	3.44	1.71	17.05	15.34	14.00		
11.55	3.03	2.32	16.90	14.58	14.00		
11.18	3.32	2.35	16.85	14.50	14.00		
10.45	4.25	1.15	15.85	14.70	14.00		
10.25	3.84	1.91	16.00	14.09	14.00		
12.60	3.77	0.41	16.78	16.37	14.00		
11.00	3.59	0.96	15.55	14.59	14.00		
11.28	3.61	1.54	16.43	14.88	14.00	$15.92	$14.98
11.15	4.26	1.37	16.78	15.41	14.00		
11.25	2.57	1.96	15.78	13.82	14.00		
10.50	4.66	1.57	16.73	15.16	14.00		
10.58	4.42	1.50	16.50	15.00	14.00		
10.70	4.38	1.87	16.95	15.08	14.00		
9.85	4.28	1.60	15.73	14.13	14.00		
9.25	5.36	2.82	17.43	14.61	14.00		
13.40	4.85	1.45	19.70	18.25	14.00		
10.23	4.22	1.58	16.03	14.45	14.00		
9.18	5.76	0.79	15.73	14.94	14.00		
9.08	4.61	1.86	15.55	13.69	14.00		
8.63	5.13	1.12	14.88	13.76	14.00		
8.95	5.07	1.21	15.23	14.02	14.00		
9.48	4.52	1.20	15.20	14.00	14.00		
9.00	4.45	1.70	15.15	13.45	14.00		
8.53	4.42	1.08	14.03	12.95	14.00		
9.78	5.20	0.65	15.63	14.98	14.00		
7.75	5.62	1.06	14.43	13.37	14.00		
10.53	4.45	1.70	16.68	14.98	14.00		
9.89	4.64	1.48	16.01	14.53	14.00	$15.55	$14.98

ACID

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Mississippi Fertilizer Co., Jackson, Miss.		
Standard Acid Phosphate	2287	2
	2343	1
Average		3
New Orleans Acid and Fertilizer Co., Gretna, La.		
Black Diamond Acid Phosphate	2457	3
	2512	3
	2544	4
	2584	2
	2728	4
	2779	7
	2873	4
	2947	3
	3032	3
	3226	9
	3281	1
	3378	6
	3579	3
	3714	2
	3794	1
	3841	1
Average		56
Crescent City Acid Phosphate	2247	1
	2291	1
	2460	1
	2514	1
	2546	2
	2589	1
	2727	4
	2872	4
	2948	3
	3039	2
	3070	1
	3176	10
	3297	6
	3392	6
	3578	17
	3713	2
	3867	1
	3943	1
	4215	1
	4348	2
	4366	1
Average		68

PHOSPHATES.

PHOSPHORIC ACID						Comparative Value Per Ton	
				Available			
Soluble Found %	Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found	Guarant'd
10.93	3.25	0.68	14.86	14.18	12.00		
11.88	4.59	0.73	17.20	16.47	12.00		
11.41	3.92	0.71	16.03	15.33	12.00	$16.40	$12.34
10.78	2.20	0.07	13.05	12.98	12.00		
10.33	2.05	0.07	12.45	12.38	12.00		
10.55	2.16	0.42	13.13	12.71	12.00		
11.08	2.35	0.25	13.68	13.43	12.00		
10.15	3.00	0.18	13.33	13.15	12.00		
10.05	2.64	0.19	12.88	12.69	12.00		
9.65	2.93	0.22	12.80	12.58	12.00		
9.65	2.61	0.17	12.43	12.26	12.00		
9.55	2.47	0.26	12.28	12.02	12.00		
9.50	2.55	0.20	12.25	12.05	12.00		
10.55	3.01	0.09	13.65	13.56	12.00		
10.10	2.46	1.37	13.93	12.56	12.00		
10.33	2.22	1.25	13.80	12.55	12.00		
9.95	2.08	1.52	13.55	12.03	12.00		
9.68	1.81	0.54	12.03	11.49	12.00		
12.08	0.56	1.51	14.15	12.64	12.00		
10.25	2.32	0.52	13.09	12.57	12.00	$13.45	$12.84
8.40	6.42	1.31	16.13	14.82	12.00		
10.63	3.24	0.28	14.15	13.87	12.00		
10.83	2.15	0.10	13.08	12.98	12.00		
12.68	1.50	0.25	14.43	14.18	12.00		
13.33	2.05	0.40	15.78	15.38	12.00		
11.05	1.98	0.20	13.23	13.03	12.00		
10.03	3.59	1.21	14.83	13.62	12.00		
9.70	2.70	0.90	13.30	12.40	12.00		
10.10	2.52	0.81	13.43	12.62	12.00		
9.75	2.83	0.22	12.80	12.58	12.00		
9.63	2.57	0.30	12.50	12.20	12.00		
11.52	2.16	0.37	14.05	13.68	12.00		
10.38	2.55	0.40	13.33	12.93	12.00		
10.48	2.73	0.52	13.73	13.21	12.00		
11.00	2.50	0.30	13.80	13.50	12.00		
10.05	4.07	0.81	14.93	14.12	12.00		
12.15	2.08	0.15	14.38	14.23	12.00		
8.90	3.73	1.00	13.63	12.63	12.00		
9.18	4.02	0.55	13.75	13.20	12.00		
10.03	5.85	1.02	16.90	15.88	12.00		
11.50	4.51	1.81	17.82	16.01	12.00		
10.54	3.13	0.62	14.28	13.67	12.00	$14.63	$12.84

		ACID
Manufacturer or Jobber and Brand	Station Number	Number of samples composited
New Orleans Acid and Fertilizer Co.—Continued.		
High-Grade Acid Phosphate	2289	1
	2422	1
	2586	1
	2733	1
	2871	2
	2988	2
	3109	1
	3225	4
	3372	5
	3508	6
	3650	3
	3772	2
	4002	2
	4245	1
	4367	1
	4370	1
	4401	1
Average		35
Planters' Fertilizer and Chemical Co., New Orleans, La.		
Planters' Acid Phosphate	2545	2
	2782	2
	2896	2
	3107	1
	3296	2
	3435	3
	3641	1
Average		13
Planters' High-Grade Acid Phosphate	2245	1
	2477	1
	2550	1
	2583	3
	2650	1
	2661	1
	2870	2
	2950	2
	3104	1
	3222	1
Average		14

PHOSPHATES.

PHOSPHORIC ACID						Comparative Value Per Ton	
				Available			
Soluble Found %	Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found	Guarant'd
13.68	2.50	0.02	16.20	16.18	16.00		
14.30	1.60	0.17	16.07	15.90	16.00		
14.08	1.65	0.20	15.93	15.73	16.00		
12.80	3.81	1.47	18.08	16.61	16.00		
12.63	3.62	0.75	17.00	16.25	16.00		
12.03	3.12	0.91	16.06	15.15	16.00		
13.30	3.59	0.16	17.05	16.89	16.00		
13.88	1.90	0.12	15.90	15.78	16.00		
11.35	4.65	0.80	16.80	16.00	16.00		
11.38	3.03	1.07	15.48	14.41	16.00		
11.63	3.67	0.60	15.90	15.30	16.00		
11.80	4.28	1.42	17.50	16.08	16.00		
13.15	3.74	0.24	17.13	16.89	16.00		
11.33	6.23	0.87	18.43	17.56	16.00		
11.05	4.99	1.76	17.80	16.04	16.00		
12.18	3.71	2.09	17.98	15.89	16.00		
12.83	2.86	2.91	18.60	15.69	16.00		
12.55	3.47	0.92	16.93	16.02	16.00	$17.14	$17.12
11.90	1.97	1.63	15.50	13.87	12.00		
11.98	4.20	0.85	17.03	16.18	12.00		
11.43	4.99	2.13	18.55	16.42	12.00		
10.23	3.34	2.11	15.68	13.57	12.00		
10.05	2.83	2.45	15.33	12.88	12.00		
9.50	3.43	2.50	15.43	12.93	12.00		
8.73	4.14	2.53	15.40	12.87	12.00		
10.55	3.56	2.03	16.13	14.10	12.00	$15.09	$12.84
9.80	3.78	1.10	14.68	13.58	14.00		
11.48	5.67	0.85	18.00	17.15	14.00		
11.68	2.41	2.11	16.20	14.09	14.00		
10.63	3.90	1.60	16.13	14.53	14.00		
11.53	5.36	0.96	17.85	16.89	14.00		
10.30	3.50	2.35	16.15	13.80	14.00		
10.35	3.89	1.76	16.00	14.24	14.00		
10.65	3.13	2.57	16.35	13.78	14.00		
10.40	2.28	3.52	16.20	12.68	14.00		
9.65	5.50	1.25	16.40	15.15	14.00		
10.65	3.94	1.81	16.40	14.50	14.00	$15.52	$14.98

ACID

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Planters' Fertilizer and Chemical Co.—Continued.		
Planters' High-Grade Acid Phosphate	2246	1
	2815	1
	2841	2
	2909	1
	3106	1
	3373	1
	3509	2
	3983	1
Average		10
Planters' High-Grade Acid Phosphate	2813	2
	3458	3
	3584	2
	3942	1
	4038	1
Average		9
Ruston Oil Mill and Manufacturing Co., Ruston, La.		
A-1 Acid Phosphate	3149	1
	3310	7
	3505	9
	3704	3
	3948	2
	4276	1
Average		23
Sonia Cotton Oil Co., Alexandria, La.		
Sonia Acid Phosphate	3795	1

PHOSPHATES.

PHOSPHORIC ACID						Comparative Value Per Ton	
				Available			
Soluble Found %	Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found	Guarant'd
14.93	3.18	1.27	19.38	18.11	16.00		
11.25	4.72	0.93	16.90	15.97	16.00		
10.45	4.11	2.80	17.36	14.56	16.00		
10.23	4.79	1.88	16.90	15.02	16.00		
11.90	5.24	1.01	18.15	17.14	16.00		
10.35	3.96	1.67	15.98	14.31	16.00		
9.43	5.79	2.05	17.27	15.22	16.00		
10.05	5.61	0.87	16.53	15.66	16.00		
11.07	4.68	1.56	17.31	15.75	16.00	$16.85	$17.12
10.65	3.82	1.61	16.08	14.47	14.10		
9.30	5.05	2.73	17.08	14.35	14.10		
8.93	5.49	2.66	17.08	14.42	14.10		
9.65	4.91	2.32	16.88	14.56	14.10		
10.83	4.48	2.12	17.43	15.31	14.10		
9.87	4.75	2.29	16.91	14.62	14.10	$15.64	$15.09
9.63	4.16	4.24	18.03	13.79	14.00		
11.05	3.23	4.00	18.28	14.28	14.00		
10.68	3.11	1.88	15.67	13.79	14.00		
10.13	4.26	1.41	15.80	14.39	14.00		
10.05	5.47	1.11	16.63	15.52	14.00		
9.60	4.57	1.78	15.95	14.17	14.00		
10.19	4.13	2.40	16.73	14.32	14.00	$15.32	$14.98
9.55	3.90	2.36	15.81	13.45	14.00	$14.39	$14.98

ACID

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Standard Guano and Chemical Manufacturing Co., New Orleans, La.		
Acid Phosphate	2288	2
	2377	3
	2414	1
	2458	2
	2511	2
	2547	4
	2592	1
	2648	3
	2684	1
	2704	3
	2780	3
	2840	3
	2907	4
	2949	4
	3041	3
	3130	4
	3175	6
	3288	7
	3451	9
	3577	5
	3712	3
	3896	5
	4235	2
	4331	2
	4386	1
	4412	1
Average		84
Acid Phosphate	2590	1
	2649	1
	3008	1
	3158	2
	3423	1
	3647	1
Average		7

PHOSPHATES.

PHOSPHORIC ACID						Comparative Value Per Ton	
				Available			
Soluble Found %	Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found	Guarant'd
10.48	4.09	2.66	17.23	14.57	14.00		
10.20	4.21	2.22	16.63	14.41	14.00		
11.58	3.51	2.19	17.28	15.09	14.00		
10.70	3.85	2.53	17.08	14.55	14.00		
11.80	2.81	2.82	17.43	14.61	14.00		
11.35	3.02	2.71	17.08	14.37	14.00		
11.10	3.65	1.90	16.65	14.75	14.00		
11.90	3.81	2.17	17.88	15.71	14.00		
11.43	2.89	3.01	17.33	14.32	14.00		
11.03	3.49	2.26	16.78	14.52	14.00		
11.63	3.63	1.57	16.83	15.26	14.00		
10.68	3.23	2.87	16.78	13.91	14.00		
11.15	4.03	1.87	17.05	15.18	14.00		
10.98	5.56	1.71	18.25	16.54	14.00		
10.38	5.22	1.75	17.35	15.60	14.00		
11.13	3.39	2.31	16.83	14.52	14.00		
11.30	3.48	2.20	16.98	14.78	14.00		
11.00	3.56	2.14	16.70	14.56	14.00		
10.68	3.55	2.75	16.98	14.23	14.00		
10.68	3.90	2.20	16.78	14.58	14.00		
10.38	4.05	2.40	16.83	14.43	14.00		
5.05	9.29	2.21	16.55	14.34	14.00		
11.20	4.12	1.71	17.03	15.32	14.00		
10.30	4.34	2.19	16.83	14.64	14.00		
10.95	4.23	0.72	15.90	15.18	14.00		
11.45	3.61	0.54	15.60	15.06	14.00		
10.79	4.02	2.14	16.95	14.81	14.00	$15.85	$14.98
11.50	2.56	2.92	16.98	14.06	12.00		
10.43	4.12	1.98	16.53	14.55	12.00		
10.13	3.57	2.53	16.23	13.70	12.00		
11.15	3.94	1.66	16.75	15.09	12.00		
10.55	3.95	1.88	16.38	14.50	12.00		
10.40	3.23	2.50	16.13	13.63	12.00		
10.69	3.56	2.25	16.50	14.26	12.00	$15.26	$12.84

ACID

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Standard Guano and Chemical Manufacturing Co.—Continued.		
Acid Phosphate	2816	1
	2980	1
	3071	3
	3157	5
	3457	3
	3585	3
	3643	1
	3982	1
	4163	1
Average		19
Stern's Dissolved Bone	3589	1
Swift's Fertilizer Works, Atlanta, Ga.		
Swift's Cultivator High Grade Acid Phosphate	2587	1
Tennessee Chemical Co., Nashville, Tenn.		
Acid Phosphate	3011	1
	3252	3
	3389	3
	3510	1
	3738	1
	3839	2
Average		11
Virginia-Carolina Chemical Co., Jackson, Miss.		
Scott's High-Grade Acid Phosphate	3462	1
Virginia-Carolina High Grade Acid Phosphate	4050	2
Virginia-Carolina Chemical Co., Jackson, Miss.		
Scott's High Grade Acid Phosphate	3253	3
	3976	1
	4218	1
Average		5
Virginia-Carolina Superphosphate	3718	1

PHOSPHATES.

PHOSPHORIC ACID						Comparative Value Per Ton	
				Available			
Soluble Found %	Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found	Guarant'd
12.93	2.77	0.73	16.43	15.70	16.00		
13.70	2.48	0.80	16.98	16.18	16.00		
12.80	3.38	1.17	17.35	16.18	16.00		
13.25	3.40	1.05	17.70	16.65	16.00		
14.95	1.57	0.63	17.15	16.52	16.00		
13.85	1.98	0.62	16.45	15.83	16.00		
14.08	2.37	0.78	17.23	16.45	16.00		
14.00	2.33	1.65	17.98	16.33	16.00		
14.08	3.00	0.80	17.88	17.08	16.00		
13.74	2.59	0.91	17.24	16.32	16.00	$17.46	$17.12
14.93	1.85	0.65	17.43	16.78	15.00	$17.95	$16.05
10.25	4.21	2.17	16.63	14.46	14.00	$15.47	$14.98
10.00	4.07	2.06	16.13	14.07	16.00		
12.88	2.55	1.95	17.38	15.43	16.00		
12.10	3.32	1.81	17.23	15.42	16.00		
12.55	2.84	1.41	16.80	15.39	16.00		
11.30	3.42	2.03	16.75	14.72	16.00		
11.18	4.53	1.57	17.28	15.71	16.00		
11.67	3.46	1.81	16.93	15.12	16.00	$16.18	$17.12
10.65	3.73	1.80	16.18	14.38	14.00	$15.39	$14.98
10.08	4.92	1.08	16.08	15.00	14.00	$16.05	$14.98
11.18	3.95	1.82	16.95	15.13	14.00		
8.80	4.70	1.40	14.90	13.50	14.00		
10.78	5.84	1.31	17.93	16.62	14.00		
10.35	4.83	1.51	16.59	15.08	14.00	$16.14	$14.98
11.25	6.14	2.16	19.55	17.39	16.00	$18.61	$17.12

ACID

Manufacturer or Jobber and Brand	Station Numbe	Number of a composited
Virginia-Carolina Chemical Co., Mobile, Ala.		
Royal Acid Phosphate	3248	1
	3848	2
Average		3
Virginia-Carolina Chemical Co., Shreveport, La.		
Royal Acid Phosphate	2918	2
	3105	1
	3233	4
	3582	2
	3721	1
Average		10
Scott's High Grade Acid Phosphate	2337	3
	2549	1
	2594	1
	2621	1
	2685	1
	2732	1
	2817	4
	2913	4
	3043	2
	3159	3
	3309	7
	3455	6
	3583	4
	3720	1
	3847	1
	4133	1
Average		41
Virginia-Carolina High-Grade Acid Phosphate	2931	1
	3242	1
	3388	2
	3588	1
Average		5

PHOSPHATES.

PHOSPHORIC ACID						Comparative Value Per Ton	
				Available			
Soluble Found	Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found	Guarant'd
8.80	4.05	3.00	15.85	12.85	12.00		
8.05	4.07	1.51	13.63	12,12	12.00		
8.43	4.06	2.26	14.74	12.49	12.00	$13.36	$12.84
11.43	4.72	2.85	19.00	16.15	12.00		
13.43	6.56	2.22	22.21	19.99	12.00		
6.93	5.42	2.28	14.63	12.35	12.00		
10.73	6.67	0.80	18.20	17.40	12.00		
6.70	5.88	1.45	14.03	12.58	12.00		
9.84	5.85	1.92	17.61	15.69	12.00	$16.79	$12.84
9.40	4.20	1.88	15.48	13.60	14.00		
12.78	2.11	2.01	16.90	14.89	14.00		
12.95	3.02	1.33	17.30	15.97	14.00		
13.60	2.45	1.73	17.78	16.05	14.00		
12.98	3.28	1.92	18.18	16.26	14.00		
8.75	6.35	0.75	15.85	15.10	14.00		
11.20	4.44	1.86	17.50	15.64	14.00		
11.05	7.44	0.54	19.03	18.49	14.00		
9.80	6.27	1.58	17.65	16.07	14.00		
9.18	5.02	2.40	16.60	14.20	14.00		
9.40	3.84	2.51	15.75	13.24	14.00		
10.20	6.43	1.12	17.75	16.63	14.00		
10.78	6.15	0.62	17.55	16.93	14.00		
9.75	6.84	0.91	17.50	16.59	14.00		
10.55	6.09	0.76	17.40	16.64	14.00		
8.20	6.48	0.85	15.53	14.68	14.00		
10.66	5.03	1.42	17.12	15.69	14.00	$16.79	$14.98
9.00	4.51	1.87	15.38	13.51	14.00		
10.70	3.42	1.71	15.83	14.12	14.00		
9.05	4.84	2.41	16.30	13.89	14.00		
11.15	6.51	0.82	18.48	17.66	14.00		
9.98	4.82	1.70	16.50	14.80	14.00	$15.84	$14.98

ACID

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Virginia-Carolina Chemical Co.—Continued.		
Virginia-Carolina Superphosphate	2515	1
	2588	1
	2812	3
	2951	2
	3103	3
	3235	3
	3386	3
	3644	1
	3724	1
	3844	1
	4318	1
Average		20

BONE

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Armour Fertilizer Works, Omaha, Neb.		
Bone Meal	3110	1
Gulfport Cotton Oil Fertilizer and Manufacturing Co., Gulfport, Miss.		
Primo Raw Ground Bone	2283	3
	2340	1
	2412	1
	2432	1
	2555	1
	3516	2
	4404	1
Average		10
Jackson Fertilizer Co., Jackson, Miss.		
Bone Meal	4036	1

PHOSPHATES.

PHOSPHORIC ACID						Comparative Value Per Ton	
				Available			
Soluble Found %	Reverted Found %	Insoluble Found %	Total Found %	Found %	Guarant'd %	Found	Guarant'd
11.50	3.71	2.37	17.58	15.21	16.00		
11.33	4.39	2.11	17.83	15.72	16.00		
10.88	5.63	1.22	17.73	16.51	16.00		
11.70	7.02	0.68	19.40	18.72	16.00		
11.48	5.58	1.22	18.28	17.06	16.00		
12.43	5.31	1.26	19.00	17.74	16.00		
12.15	5.60	1.08	18.83	17.75	16.00		
9.63	8.32	1.28	19.23	17.95	16.00		
8.95	6.89	1.11	16.95	15.84	16.00		
13.00	5.84	0.91	19.75	18.84	16.00		
8.28	6.59	1.26	16.13	14.87	16.00		
11.03	5.90	1.32	18.25	16.94	16.00	$18.13	$17.12

MEALS.

PHOSPHORIC ACID Total		NITROGEN		Ammonia Found %	Comparative Value Per Ton	
Found %	Guarant'd %	Found %	Guarant'd %		Found	Guarant'd
27.35	24.00	2.60	2.47	3.16	$31.24	$28.09
25.25	20.00	3.46	3.00	4.21		
25.98	20.00	3.33	3.00	4.04		
26.63	20.00	3.62	3.00	4.40		
26.85	20.00	3.44	3.00	4.18		
27.10	20.00	3.05	3.00	3.71		
26.33	20.00	3.58	3.00	4.35		
26.70	20.00	3.45	3.00	4.20		
26.41	20.00	3.42	3.00	4.16	$33.44	$26.80
27.80	22.90	2.47	2.47	3.00	$31.13	$27.21

BONE

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
New Orleans Acid and Fertilizer Co., Gretna, La.		
*Bone Meal	2946	2
	3124	1
	3283	4
Average		7
Planters' Fertilizer and Chemical Co., New Orleans, La.		
Planters' Bone Meal	2476	1
	2568	1
Average		2
Standard Guano and Chemical Manufacturing Co., New Orleans, La.		
Pure Raw Ground Bone	2238	2
	2277	24
	2358	3
	2374	3
	2385	2
	2397	3
	2456	6
	2510	1
	2542	10
	2556	2
	2645	4
	2682	9
	2726	6
	2777	9
	2839	7
	2895	5
	2956	15
	3002	5
	3064	8
	3125	11
	3177	13
	3260	11
	3327	17
	3368	5
	3517	16

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*Guaranteed 28% total phosphoric acid. This brand is figured on total phosphoric acid.

MEALS.

PHOSPHORIC ACID								Comparative Value Per-Ton	
Insol'ble	Total		Available		Nitrogen		Ammonia Found %		
Found %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %		Found %	Guarant'd %
9.43	20.55		11.12	18.00	3.14	3.00	3.81		
10.53	20.55		10.02	18.00	2.91	3.00	3.54		
7.76	18.97		11.21	18.00	2.93	3.00	3.56		
9.24	20.02		10.78	18.00	2.99	3.00	3.64	$26.78	$33.20
	22.15	16.00			3.23	2.50	3.93		
	23.40	16.00			3.10	2.50	3.77		
	22.78	16.00			3.17	2.50	3.85	$29.64	$21.80
	24.88	18.50			2.92	2.50	3.55		
	22.10	18.50			2.62	2.50	3.18		
	21.00	18.50			4.23	2.50	5.14		
	22.35	18.50			2.91	2.50	3.54		
	21.35	18.50			2.53	2.50	3.07		
	19.40	18.50			3.26	2.50	3.96		
	24.35	18.50			3.41	2.50	4.14		
	20.85	18.50			2.56	2.50	3.11		
	21.50	18.50			2.92	2.50	3.55		
	19.60	18.50			2.80	2.50	3.40		
	18.78	18.50			2.79	2.50	3.39		
	21.55	18.50			2.84	2.50	3.45		
	19.90	18.50			2.72	2.50	3.31		
	20.60	18.50			2.94	2.50	3.57		
	18.85	18.50			2.89	2.50	3.51		
	22.20	18.50			3.13	2.50	3.80		
	21.60	18.50			2.64	2.50	3.21		
	19.55	18.50			2.43	2.50	2.95		
	22.65	18.50			2.76	2.50	3.35		
	24.35	18.50			3.07	2.50	3.73		
	24.20	18.50			2.80	2.50	3.40		
	22.75	18.50			3.06	2.50	3.72		
	23.55	18.50			2.73	2.50	3.31		
	22.35	18.50			2.78	2.50	3.38		
	22.88	18.50			2.75	2.50	3.34		

BONE

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Standard Guano and Chemical Manufacturing Co.—Continued.		
	3678	9
	3796	5
	3851	5
	3903	2
	3999	2
	4060	5
	4159	3
	4197	4
	4250	3
	4396	2
Average		237
Swift's Fertilizer Works, Atlanta, Ga.		
Swift's Bone Meal, High Grade	2284	2
	2411	1
	2431	1
	2644	2
	2809	1
	2981	1
	3160	2
	3328	2
	3454	5
	3850	2
	4000	1
Average		20
Swift and Co., Limited, South St. Joseph, Mo.		
*Swift's Pure Bone Meal	4059	10

TANKAGES.

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Armour Fertilizer Works, Chicago, Ill.		
9-12 Tankage	2847	1
	2848	1
	2849	1
	2850	1
	2851	1
	2859	1
	3084	1
	3085	1
Average		8

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*This sample is guaranteed 25% total phosphoric acid. This brand is figured on total phosphoric acid.

MEALS.

PHOSPHORIC ACID									
Insol'ble	Total		Available		Nitrogen		Ammonia Found %	Comparative Value Per Ton	
Found %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %		Found	Guarant'd
	22.00	18.50			2.50	2.50	3.04		
	21.28	18.50			2.70	2.50	3.28		
	22.80	18.50			2.83	2.50	3.44		
	21.73	18.50			3.23	2.50	3.93		
	24.35	18.50			2.98	2.50	3.62		
	25.20	18.50			2.78	2.50	3.38		
	25.15	18.50			3.23	2.50	3.93		
	22.30	18.50			3.44	2.50	4.18		
	23.25	18.50			3.28	2.50	3.98		
	22.13	18.50			3.65	2.50	4.44		
	22.10	18.50			2.95	2.50	3.58	$28.30	$23.80
	25.65	25.00			3.04	2.47	3.70		
	25.68	25.00			3.30	2.47	4.01		
	29.40	25.00			2.26	2.47	2.75		
	28.90	25.00			2.46	2.47	2.99		
	28.50	25.00			2.28	2.47	2.77		
	28.65	25.00			2.29	2.47	2.78		
	28.70	25.00			2.37	2.47	2.88		
	28.10	25.00			2.32	2.47	2.82		
	27.88	25.00			2.47	2.47	3.00		
	28.25	25.00			2.23	2.47	2.71		
	28.10	25.00			2.59	2.47	3.15		
	27.89	25.00			2.51	2.47	3.05	$31.35	$28.89
14.78	28.65		13.87	11.25	2.84	2.50	3.45	$33.14	$29.00

TANKAGES.

3.57	9.45		5.88	2.75	7.64	7.41	9.29		
3.43	8.63		5.20	2.75	7.57	7.41	9.20		
3.42	9.40		5.98	2.75	7.46	7.41	9.07		
3.43	10.13		6.70	2.75	6.90	7.41	8.39		
3.58	9.33		5.75	2.75	7.41	7.41	9.01		
3.82	9.48		5.66	2.75	7.30	7.41	8.87		
2.36	7.83		5.47	2.75	7.28	7.41	8.85		
2.81	7.75		4.94	2.75	7.21	7.41	8.76		
3.30	9.00		5.70	2.75	7.35	7.41	8.93	$26.07	$25.53

TANKAGES

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Armour Fertilizer Works, Chicago, Ill.—Continued.		
10-10 Tankage	2748	1
	3567	1
	3568	1
	3569	1
	3570	1
Average		5
Armour Fertilizer Works, Kansas City, Kans.		
9-12 Tankage	3489	1
	3490	1
	3829	1
Average		3
Planters' Fertilizer and Chemical Co., New Orleans and Shrewsbury, La.		
*Imported Foreign Tankage	3753	1
Swift and Co., Ltd., Union Stock Yards, Chicago, Ill.		
Swift's High Grade Ground Tankage	2966	1
	3012	1
	3082	1
	3090	1
	3612	1
	3615	1
Average		6
High Grade Tankage	3923	1
	3924	1
	3925	1
	4028	1
	4173	1
	4379	1
	4380	1
Average		7
High Grade Tankage	4026	1

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*This sample is composed of wool waste, shoddy, hair and leather. There was 3.50 per cent available nitrogen found and the sample was examined for phosphoric acid, and only a trace was found.

TANKAGES

PHOSPHORIC ACID									
Insol'ble	Total		Available		Nitrogen		Ammonia Found %	Comparative Value Per Ton	
Found %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %		Found	Guarant'd
2.84	6.90		4.06	2.00	8.43	8.23	10.25		
2.14	8.18		6.04	2.00	8.15	8.23	9.91		
1.72	7.13		5.41	2.00	8.42	8.23	10.23		
2.14	7.30		5.16	2.00	8.45	8.23	10.27		
2.62	8.18		5.56	2.00	7.75	8.23	9.42		
2.29	7.54		5.25	2.00	8.24	8.23	10.02	$28.70	$28.00
2.68	7.30		4.62	2.75	7.75	7.41	9.42		
2.76	7.18		4.42	2.75	7.41	7.41	9.01		
2.46	7.18		4.72	2.75	7.57	7.41	9.20		
2.63	7.22		4.59	2.75	7.58	7.41	9.21	$26.44	$25.53
					7.19	7.86	8.74	$23.60	$25.79
	4.83	3.00			7.16	6.58	8.70		
	4.50	3.00			6.76	6.58	8.22		
	4.40	3.00			6.95	6.58	8.45		
	4.48	3.00			6.66	6.58	8.09		
	5.43	3.00			6.93	6.58	8.42		
	4.33	3.00			6.19	6.58	7.52		
	4.66	3.00			6.78	6.58	8.23	$22.80	$22.25
	3.33	4.00			7.85	8.23	9.54		
	4.05	4.00			7.44	8.23	9.04		
	3.55	4.00			7.34	8.23	8.92		
	4.33	4.00			8.11	8.23	9.86		
	4.53	4.00			7.10	8.23	8.63		
	4.80	4.00			7.26	8.23	8.82		
	4.63	4.00			7.20	8.23	8.75		
	4.17	4.00			7.47	8.23	9.08	$25.43	$27.87
	5.53	4.00			7.91	7.41	9.61	$27.15	$25.20

TANKAGES

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Swift and Co., Ltd., National Stock Yards, East St. Louis, Ill.		
High Grade Tankage	2257	1
	2268	1
	2299	1
	2303	1
	2305	1
	2308	1
	2311	1
	2314	1
	2315	1
	2316	1
	2319	1
	2320	1
	2321	1
	2322	1
	2323	1
	2631	1
	3593	1
	3594	1
	3595	1
	3602	1
	3603	1
Average		21
High Grade Tankage	2259	1
	2627	1
	2628	1
	2629	1
	2630	1
	3590	1
	3591	1
	3592	1
	4180	1
Average		9
Swift's High Grade Ground Tankage	2481	1
	2483	1
	2552	1
	2625	1
	2626	1
	2749	1
	2750	1
	2751	1
	2752	1
	2753	1

TANKAGES

PHOSPHORIC ACID Total		NITROGEN		Ammonia Found %	Comparative Value Per Ton	
Found %	Guarant'd %	Found %	Guarant'd %		Found	Guarant'd
6.63	4.00	8.46	8.23	10.28		
5.88	4.00	8.25	8.23	10.03		
6.38	4.00	7.55	8.23	9.17		
6.63	4.00	7.64	8.23	9.28		
6.55	4.00	7.07	8.23	8.59		
6.45	4.00	8.07	8.23	9.81		
6.38	4.00	8.24	8.23	10.02		
6.55	4.00	7.80	8.23	9.48		
5.70	4.00	7.03	8.23	8.54		
7.00	4.00	8.19	8.23	9.95		
5.98	4.00	8.28	8.23	10.06		
5.68	4.00	8.27	8.23	10.05		
6.10	4.00	8.27	8.23	10.05		
6.40	4.00	7.54	8.23	9.16		
6.20	4.00	8.24	8.23	10.02		
5.90	4.00	8.19	8.23	9.95		
6.35	4.00	7.91	8.23	9.61		
6.03	4.00	7.80	8.23	9.48		
6.48	4.00	7.92	8.23	9.62		
4.65	4.00	8.24	8.23	10.01		
4.88	4.00	8.60	8.23	10.45		
6.13	4.00	7.98	8.23	9.70	$27.53	$27.87
7.18	4.00	7.69	7.41	9.34		
5.43	4.00	7.06	7.41	8.58		
5.15	4.00	7.00	7.41	8.51		
5.08	4.00	7.41	7.41	9.01		
5.10	4.00	6.95	7.41	8.45		
5.45	4.00	6.78	7.41	8.24		
5.55	4.00	6.92	7.41	8.41		
5.40	4.00	6.53	7.41	7.94		
6.95	4.00	7.54	7.41	9.16		
5.70	4.00	7.10	7.41	8.63	$24.54	$25.20
5.33	3.00	6.63	6.58	8.06		
5.15	3.00	6.58	6.58	8.00		
5.00	3.00	7.20	6.58	8.75		
4.60	3.00	6.31	6.58	7.67		
4.73	3.00	6.41	6.58	7.79		
4.50	3.00	6.76	6.58	8.22		
4.45	3.00	6.44	6.58	7.83		
3.80	3.00	6.28	6.58	7.63		
4.80	3.00	6.19	6.58	7.52		
4.00	3.00	7.46	6.58	9.07		

TANKAGES

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Swift and Co., Ltd., National Stock Yards.—Continued.		
	3026	1
	3027	1
	3028	1
	3029	1
	3030	1
	3910	1
	3911	1
	4255	1
Average		18
Swift's High Grade Tankage	2663	1
	2664	1
	2665	1
	2666	1
	2695	1
	2794	1
	3277	1
	3914	1
	3919	1
	3920	1
	3965	1
	3967	1
	3968	1
	3969	1
	3970	1
	3971	1
	4101	1
	4252	1
	4253	1
	4254	1
Average		20
Swift and Co., Ltd., Fort Worth, Tex.		
Swift's High Grade Tankage	3777	1
	4292	1
Average		2

TANKAGES

PHOSPHORIC ACID Total		NITROGEN		%	Comparative Value Per Ton	
Found %	Guarant'd %	Found %	Guarant'd %	Ammonia F	Found	Guarant'd
4.65	3.00	6.30	6.58	7.66		
4.48	3.00	6.75	6.58	8.20		
4.45	3.00	6.19	6.58	7.52		
5.55	3.00	6.51	6.58	7.91		
4.52	3.00	6.58	6.58	8.00		
5.90	3.00	6.34	6.58	7.71		
5.65	3.00	6.61	6.58	8.03		
5.23	3.00	6.44	6.58	7.83		
4.82	3.00	6.55	6.58	7.96	$22.54	$22.25
7.15	6.87	7.40	7.40	8.99		
7.18	6.87	7.42	7.40	9.02		
7.73	6.87	6.98	7.40	8.48		
7.70	6.87	7.11	7.40	8.64		
7.00	6.87	7.34	7.40	8.92		
7.58	6.87	7.31	7.40	8.88		
6.05	6.87	7.40	7.40	8.99		
7.43	6.87	7.45	7.40	9.05		
7.20	6.87	7.37	7.40	8.96		
6.03	6.87	7.42	7.40	9.02		
7.83	6.87	7.48	7.40	9.09		
6.60	6.87	7.26	7.40	8.82		
6.60	6.87	7.63	7.40	9.27		
7.05	6.87	7.50	7.40	9.12		
9.15	6.87	7.19	7.40	8.74		
8.00	6.87	7.43	7.40	9.03		
7.40	6.87	7.55	7.40	9.17		
6.75	6.87	7.53	7.40	9.15		
7.55	6.87	7.32	7.40	8.90		
7.23	6.87	7.28	7.40	8.85		
7.26	6.87	7.37	7.40	8.95	$25.75	$25.77
6.55	6.87	6.88	7.41	8.36		
7.00	6.87	7.39	7.41	8.98		
6.78	6.87	7.14	7.41	8.67	$24.89	$25.82

TANKAGES

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Swift and Co.—Continued.		
High Grade Tankage..................................	2241	1
	2242	1
	2258	1
	2267	1
	2368	1
	2553	1
	2509	1
	2610	1
	2611	1
	2662	1
	2745	1
	2746	1
	2970	1
	2971	1
	3088	1
	3089	1
	3278	1
	3279	1
	3406	1
	3414	1
Average..		20
Swift's High Grade Ground Tankage..............	2301	1
	2350	1
	2362	1
	2363	1
	2364	1
	2365	1
	2366	1
	2443	1
	2612	1
	2692	1
	2693	1
	2694	1
	2747	1
	2796	1
	2852	1
	2969	1
	3215	1
	3408	1

TANKAGES

PHOSPHORIC ACID Total		NITROGEN		Ammonia Found %	Comparative Value Per Ton	
Found %	Guarant'd %	Found %	Guarant'd %		Found	Guarant'd
10.00	4.00	6.97	7.41	8.47		
8.90	4.00	7.26	7.41	8.82		
8.38	4.00	7.42	7.41	9.02		
9.50	4.00	7.42	7.41	9.02		
8.53	4.00	7.45	7.41	9.05		
6.08	4.00	7.16	7.41	8.70		
5.73	4.00	7.32	7.41	8.90		
5.63	4.00	7.32	7.41	8.90		
5.90	4.00	7.37	7.41	8.96		
5.68	4.00	7.18	7.41	8.73		
5.53	4.00	8.13	7.41	9.88		
5.43	4.00	7.72	7.41	9.38		
5.83	4.00	7.18	7.41	8.73		
6.70	4.00	7.36	7.41	8.95		
7.75	4.00	7.11	7.41	8.64		
5.33	4.00	7.19	7.41	8.74		
5.03	4.00	7.24	7.41	8.80		
4.83	4.00	7.09	7.41	8.62		
5.33	4.00	7.02	7.41	8.53		
6.90	4.00	7.55	7.41	9.17		
6.65	4.00	7.32	7.41	8.90	$25.48	$25.20
5.65	3.00	6.61	6.58	8.03		
4.88	3.00	6.48	6.58	7.89		
4.33	3.00	6.58	6.58	7.99		
4.45	3.00	6.68	6.58	8.12		
4.63	3.00	6.58	6.58	7.99		
4.60	3.00	6.68	6.58	8.12		
4.25	3.00	6.58	6.58	7.99		
5.78	3.00	6.89	6.58	8.37		
5.43	3.00	7.37	6.58	8.96		
5.28	3.00	7.16	6.58	8.70		
5.15	3.00	7.07	6.58	8.59		
5.55	3.00	6.90	6.58	8.39		
5.05	3.00	7.58	6.58	9.21		
5.08	3.00	6.08	6.58	7.39		
5.75	3.00	6.33	6.58	7.69		
4.90	3.00	6.43	6.58	7.82		
5.53	3.00	6.26	6.58	7.61		
7.45	3.00	7.05	6.58	8.57		

TANKAGES

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Swift and Co.—Continued.		
	3409	1
	3410	1
	3413	1
	3518	1
	3519	1
	3520	1
	3521	1
	3522	1
	3523	1
	3524	1
	3525	1
	3526	1
	3527	1
	3528	1
	4099	1
	4100	1
	4176	1
	4285	1
	4287	1
	4288	1
	4289	1
	4290	1
	4291	1
	4286	1
Average..		42
High Grade Tankage..............................	2306	1
	2312	1
	2317	1
Average..		3
High Grade Tankage..............................	2379	1
	2380	1
	2381	1
	2436	1
	2437	1
	2438	1
	2439	1
	2440	1
	2441	1
	2442	1
	2444	1

TANKAGES

PHOSPHORIC ACID Total		NITROGEN		Ammonia Found %	Comparative Value Per Ton	
Found %	Guarant'd %	Found %	Guarant'd %		Found	Guarant'd
4.95	3.00	6.74	6.58	8.19		
9.15	3.00	6.99	6.58	8.50		
5.08	3.00	6.43	6.58	7.82		
7.63	3.00	6.57	6.58	7.99		
7.90	3.00	7.14	6.58	8.68		
9.25	3.00	7.07	6.58	8.59		
5.75	3.00	6.34	6.58	7.71		
3.45	3.00	6.39	6.58	7.77		
3.70	3.00	6.16	6.58	7.49		
8.25	3.00	6.82	6.58	8.29		
8.70	3.00	6.94	6.58	8.43		
7.70	3.00	7.10	6.58	8.63		
7.50	3.00	6.79	6.58	8.25		
3.65	3.00	6.30	6.58	7.66		
7.60	3.00	6.59	6.58	8.01		
7.85	3.00	7.40	6.58	8.99		
7.25	3.00	7.25	6.58	8.81		
5.73	3.00	6.83	6.58	8.30		
5.50	3.00	6.82	6.58	8.29		
4.90	3.00	6.32	6.58	7.68		
4.93	3.00	6.73	6.58	8.18		
5.05	3.00	6.64	6.58	8.07		
5.15	3.00	6.58	6.58	8.00		
5.50	3.00	6.89	6.58	8.37		
5.85	3.00	6.74	6.58	8.19	$23.39	$22.25
7.53	3.50	6.71	6.58	8.16		
6.68	3.50	6.36	6.58	7.74		
6.18	3.50	7.04	6.58	8.56		
6.80	3.50	6.70	6.58	8.15	$23.49	$22.36
5.58	4.00	7.82	8.23	9.50		
6.38	4.00	8.30	8.23	10.09		
5.13	4.00	7.95	8.23	9.66		
6.28	4.00	8.05	8.23	9.78		
6.03	4.00	8.11	8.23	9.86		
6.50	4.00	8.08	8.23	9.82		
6.33	4.00	8.32	8.23	10.11		
6.58	4.00	8.10	8.23	9.85		
6.58	4.00	7.69	8.23	9.35		
6.23	4.00	8.23	8.23	10.00		
6.40	4.00	7.90	8.23	9.60		

TANKAGES

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Swift and Co.—Continued.		
	2445	1
	2482	1
	2554	1
	2607	1
	2608	1
	2668	1
	2696	1
	2972	1
	3206	1
	3207	1
	3216	1
Average		22
Tankage	2252	1
	2255	1
Average		2
Swift and Co., Ltd., Kansas City, Kans.		
High Grade Tankage	3597	1
	3598	1
	3599	1
	3600	1
	3601	1
	3928	1
	3929	1
	3930	1
	3931	1
	3932	1
	3596	1
Average		11
High Grade Tankage	2739	1
	2740	1
	2741	1
	2742	1
	2743	1
	2744	1
Average		6

TANKAGES

PHOSPHORIC ACID Total		NITROGEN		Ammonia Found %	Comparative Value Per Ton	
Found %	Guarant'd %	Found %	Guarant'd %		Found	Guarant'd
6.15	4.00	8.23	8.23	10.00		
6.50	4.00	8.31	8.23	10.10		
6.90	4.00	9.22	8.23	11.20		
6.13	4.00	8.32	8.23	10.11		
5.83	4.00	8.63	8.23	10.49		
4.78	4.00	8.86	8.23	10.77		
6.50	4.00	8.41	8.23	10.22		
6.08	4.00	8.36	8.23	10.16		
8.10	4.00	7.81	8.23	9.49		
6.80	4.00	8.27	8.23	10.05		
5.55	4.00	8.27	8.23	10.05		
—	—	—	—	—	—	—
6.24	4.00	8.22	8.23	9.99	$28.33	$27.87
8.60	4.58	7.68	7.41	9.33		
9.75	4.58	7.14	7.41	8.67		
—	—	—	—	—	—	—
9.18	4.58	7.41	7.41	9.00	$26.30	$25.31
5.88	4.00	8.28	8.23	10.06		
5.83	4.00	8.15	8.23	9.91		
5.63	4.00	8.15	8.23	9.91		
5.50	4.00	8.21	8.23	9.98		
5.38	4.00	8.23	8.23	10.00		
4.53	4.00	8.74	8.23	10.62		
4.80	4.00	8.78	8.23	10.66		
4.98	4.00	8.55	8.23	10.39		
4.55	4.00	8.64	8.23	10.50		
4.95	4.00	8.40	8.23	10.21		
6.03	4.00	8.36	8.23	10.16		
—	—	—	—	—	—	—
5.28	4.00	8.41	8.23	10.22	$28.75	$27.87
5.58	4.00	7.60	7.41	9.24		
5.20	4.00	8.07	7.41	9.81		
5.63	4.00	7.80	7.41	9.48		
5.70	4.00	7.91	7.41	9.61		
5.55	4.00	7.99	7.41	9.71		
5.80	4.00	7.53	7.41	9.15		
—	—	—	—	—	—	—
5.58	4.00	7.82	7.41	9.50	$26.87	$25.20

TANKAGES

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Swift and Co.—Continued.		
Swift's High Grade Tankage..........................	3849	1
	3912	1
	3913	1
	3921	1
Average..		4
Swift's High Grade Tankage..........................	2351	1
	2353	1
	2964	1
	2965	1
	3336	1
	3337	1
	3745	1
Average..		7
Swift and Co., Ltd., South Omaha, Neb.		
High Grade Tankage................................	3927	1
	3966	1
	4174	1
	4175	1
	2854	1
	2855	1
	2856	1
	2857	1
	2858	1
Average..		9
High Grade Tankage................................	2298	1
	2300	1
Average..		2
Swift's High Grade Tankage..........................	3746	1
	4025	1
	4316	1
Average..		3

TANKAGES

PHOSPHORIC ACID Total		NITROGEN		Ammonia Found %	Comparative Value Per Ton	
Found %	Guarant'd %	Found %	Guarant'd %		Found	Guarant'd
5.73	6.87	8.39	7.41	10.19		
4.93	6.87	7.70	7.41	9.36		
5.15	6.87	8.29	7.41	10.08		
4.38	6.87	8.22	7.41	9.99		
5.05	6.87	8.15	7.41	9.91	$27.86	$25.82
5.73	3.00	6.94	6.58	8.44		
6.08	3.00	6.90	6.58	8.39		
5.73	3.00	7.33	6.58	8.91		
6.02	3.00	7.24	6.58	8.80		
5.03	3.00	5.90	6.58	7.17		
5.70	3.00	5.89	6.58	7.16		
5.60	3.00	5.85	6.58	7.11		
5.70	3.00	6.58	6.58	8.00	$22.84	$22.25
5.45	4.00	7.07	7.41	8.59		
5.00	4.00	7.36	7.41	8.95		
4.48	4.00	7.58	7.41	9.21		
3.38	4.00	8.41	7.41	10.22		
5.50	4.00	7.72	7.41	9.38		
5.63	4.00	7.86	7.41	9.55		
5.50	4.00	7.74	7.41	9.41		
5.80	4.00	7.90	7.41	9.60		
5.63	4.00	7.76	7.41	9.43		
5.15	4.00	7.71	7.41	9.37	$26.42	$25.20
4.90	4.00	7.79	8.23	9.46		
5.05	4.00	8.16	8.23	9.91		
4.98	4.00	7.98	8.23	9.69	$27.25	$27.87
4.70	3.00	5.66	6.58	6.88		
4.80	3.00	6.83	6.58	8.30		
4.78	3.00	5.98	6.58	7.27		
4.76	3.00	6.16	6.58	7.48	$21.23	$22.25

TANKAGES

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Swift and Co., Ltd., South Omaha, Neb.		
Swift's High-Grade Tankage	3922	1
	3935	1
	3936	1
	3937	1
Average		4
Swift and Co., Ltd., South St. Joseph, Mo.		
High-Grade Tankage	2261	1
	3086	1
	3087	1
	3529	1
	4393	1
	4403	1
Average		6
High-Grade Tankage	2304	1
	2307	1
	2309	1
	2310	1
	2352	1
	4024	1
	4094	1
	4167	1
	4168	1
	4169	1
	4170	1
	4171	1
	4172	1
Average		13
Swift's High-Grade Tankage	2793	1
	2795	1
	2797	1
	2967	1
	2968	1
	3280	1
	3964	1
	3972	1
	3973	1
	4179	1
Average		10

TANKAGES.

PHOSPHORIC ACID Total		NITROGEN		Ammonia Found %	Comparative Value Per Ton	
Found %	Guarant'd %	Found %	Guarant'd %		Found	Guarant'd
8.75	6.87	7.30	7.41	8.87		
8.03	6.87	7.36	7.41	8.95		
5.08	6.87	7.51	7.41	9.13		
7.28	6.87	7.55	7.41	9.17		
7.29	6.87	7.43	7.41	9.03	$25.97	$25.82
3.45	4.00	8.63	8.23	10.49		
6.43	4.00	8.37	8.23	10.17		
5.90	4.00	8.68	8.23	10.55		
6.40	4.00	8.11	8.23	9.86		
6.83	4.00	7.92	8.23	9.62		
7.28	4.00	8.29	8.23	10.08		
6.05	4.00	8.33	8.23	10.13	$28.67	$27.87
5.38	4.00	7.50	7.41	9.11		
5.93	4.00	7.37	7.41	8.96		
5.68	4.00	7.58	7.41	9.21		
5.23	4.00	7.22	7.41	8.78		
4.03	4.00	7.53	7.41	9.15		
7.83	4.00	7.79	7.41	9.47		
6.90	4.00	8.20	7.41	9.97		
5.98	4.00	7.43	7.41	9.03		
6.20	4.00	7.82	7.41	9.50		
6.03	4.00	7.41	7.41	9.01		
6.13	4.00	7.04	7.41	8.56		
6.08	4.00	6.68	7.41	8.12		
6.38	4.00	7.66	7.41	9.31		
5.98	4.00	7.48	7.41	9.09	$25.85	$25.20
7.23	6.87	7.43	7.41	9.03		
7.63	6.87	7.65	7.41	9.30		
7.45	6.87	7.42	7.41	9.02		
6.85	6.87	8.01	7.41	9.74		
7.38	6.87	7.02	7.41	8.53		
8.35	6.87	6.64	7.41	8.07		
7.98	6.87	7.41	7.41	9.01		
8.38	6.87	7.45	7.41	9.05		
9.70	6.87	7.35	7.41	8.93		
7.00	6.87	7.42	7.41	9.02		
7.80	6.87	7.38	7.41	8.97	$25.92	$25.82

TANKAGES.

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Swift and Co.—Continued.		
Swift's High-Grade Ground Tankage	2256	1
	2302	1
	2313	1
	2324	1
	2325	1
	2349	1
	3604	1
	3926	1
	4095	1
	4096	1
	4097	1
	4098	1
	4208	1
	4209	1
	4210	1
	4283	1
	4284	1
Average		17
Swift and Co., Ltd., South St. Paul, Minn.		
High-Grade Tankage	2253	1
	2254	1
	2260	1
	2262	1
	2263	1
	2264	1
	2265	1
	2266	1
	2853	1
	3407	1
	3411	1
	3412	1
	3613	1
	3614	1
	3743	1
	3744	1
	4279	1
	4280	1
	4281	1
	4282	1
Average		20

TANKAGES.

PHOSPHORIC ACID Total		NITROGEN		Ammonia Found %	Comparative Value Per Ton	
Found %	Guarant'd %	Found %	Guarant'd %		Found	Guarant'd
4.00	3.00	7.60	6.58	9.24		
3.13	3.00	6.90	6.58	8.39		
3.40	3.00	6.75	6.58	8.20		
3.55	3.00	7.24	6.58	8.80		
4.38	3.00	6.88	6.58	8.52		
4.33	3.00	6.59	6.58	8.00		
5.30	3.00	7.01	6.58	8.52		
7.13	3.00	6.98	6.58	8.48		
6.23	3.00	7.32	6.58	8.90		
8.53	3.00	6.34	6.58	7.71		
7.78	3.00	6.96	6.58	8.46		
8.05	3.00	7.41	6.58	9.01		
5.90	3.00	6.89	6.58	8.37		
6.98	3.00	7.08	6.58	8.60		
7.80	3.00	7.25	6.58	8.81		
6.95	3.00	7.29	6.58	8.86		
5.15	3.00	5.67	6.58	6.89		
5.80	3.00	6.95	6.58	8.45	$24.08	$22.25
5.03	4.00	6.20	7.41	7.54		
6.20	4.00	7.20	7.41	8.75		
5.45	4.00	5.87	7.41	7.14		
5.03	4.00	6.13	7.41	7.45		
5.63	4.00	6.28	7.41	7.64		
5.40	4.00	5.98	7.41	7.27		
5.68	4.00	6.59	7.41	8.00		
6.05	4.00	7.58	7.41	9.21		
5.35	4.00	7.40	7.41	8.99		
4.68	4.00	7.20	7.41	8.75		
5.08	4.00	7.50	7.41	9.12		
4.70	4.00	7.55	7.41	9.17		
9.15	4.00	7.32	7.41	8.90		
9.20	4.00	7.36	7.41	8.95		
11.03	4.00	7.10	7.41	8.63		
10.15	4.00	7.12	7.41	8.65		
8.28	4.00	7.39	7.41	8.98		
8.93	4.00	7.41	7.41	9.01		
8.43	4.00	7.28	7.41	8.85		
9.33	4.00	7.58	7.41	9.21		
6.94	4.00	7.00	7.41	8.51	$24.49	$25.20

TANKAGES.

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Swift and Co.—Continued.		
Swift's High-Grade Ground Tankage	2367	1
	3208	1
	3209	1
Average		3
Swift's High-Grade Ground Tankage	3210	1
	3211	1
	3212	1
	3213	1
	3214	1
	3330	1
	3331	1
	3332	1
	3333	1
	3334	1
	3335	1
	3605	1
	3606	1
	3607	1
	3608	1
	3609	1
	3610	1
	3803	1
	3804	1
	3915	1
	3916	1
	3933	1
	3934	1
	4018	1
	4019	1
	4020	1
	4021	1
	4022	1
	4023	1
	4077	1
	4078	1
	4079	1
	4080	1
	4081	1
	4082	1
	4083	1
	4084	1
	4085	1
	4086	1

TANKAGES.

PHOSPHORIC ACID Total		NITROGEN		Ammonia Found %	Comparative Value Per Ton	
Found %	Guarant'd %	Found %	Guarant'd %		Found	Guarant'd
6.18	6.87	7.41	7.41	9.01		
6.78	6.87	7.16	7.41	8.70		
6.90	6.87	7.34	7.41	8.92		
6.62	6.87	7.20	7.41	8.88	$25.42	$25.82
4.58	3.00	6.10	6.58	7.41		
4.80	3.00	6.54	6.58	7.95		
4.43	3.00	5.84	6.58	7.10		
4.25	3.00	6.20	6.58	7.54		
5.20	3.00	6.71	6.58	8.16		
5.18	3.00	6.46	6.58	7.85		
5.03	3.00	6.71	6.58	8.16		
4.70	3.00	6.74	6.58	8.19		
4.83	3.00	6.79	6.58	8.25		
4.53	3.00	6.69	6.58	8.13		
4.55	3.00	6.65	6.58	8.08		
9.28	3.00	6.55	6.58	7.96		
4.58	3.00	6.51	6.58	7.91		
7.95	3.00	6.67	6.58	8.11		
4.90	3.00	6.23	6.58	7.57		
5.15	3.00	6.31	6.58	7.67		
9.00	3.00	6.00	6.58	7.29		
7.78	3.00	6.58	6.58	8.00		
7.78	3.00	6.81	6.58	8.28		
7.68	3.00	6.96	6.58	8.46		
7.70	3.00	7.39	6.58	8.98		
5.58	3.00	7.15	6.58	8.69		
7.15	3.00	7.16	6.58	8.70		
10.23	3.00	6.74	6.58	8.19		
9.85	3.00	7.03	6.58	8.54		
11.13	3.00	6.70	6.58	8.14		
11.00	3.00	6.40	6.58	7.78		
10.95	3.00	6.93	6.58	8.42		
9.80	3.00	6.93	6.58	8.42		
11.93	3.00	6.45	6.58	7.84		
13.08	3.00	5.48	6.58	6.66		
13.03	3.00	5.59	6.58	6.79		
5.00	3.00	6.45	6.58	7.84		
7.50	3.00	6.53	6.58	7.94		
11.40	3.00	6.18	6.58	7.51		
12.60	3.00	6.44	6.58	7.83		
7.28	3.00	6.58	6.58	8.00		
7.50	3.00	6.55	6.58	7.96		
8.55	3.00	6.85	6.58	8.33		

TANKAGES.

Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Swift and Co.—Continued.		
	4087	1
	4088	1
	4089	1
	4090	1
	4091	1
	4092	1
	4093	1
	4126	1
	4177	1
	4178	1
	4207	1
Average		50
High-Grade Tankage	3611	1
	4027	1
Average		2

TANKAGES.

PHOSPHORIC ACID Total		NITROGEN		Ammonia Found %	Comparative Value Per Ton	
Found %	Guarant'd %	Found %	Guarant'd %		Found	Guarant'd
13.53	3.00	6.24	6.58	7.58		
13.45	3.00	6.62	6.58	8.05		
7.65	3.00	6.60	6.58	8.02		
13.65	3.00	5.63	6.58	6.84		
13.30	3.00	6.02	6.58	7.31		
13.40	3.00	6.13	6.58	7.45		
4.20	3.00	6.68	6.58	8.12		
6.25	3.00	6.79	6.58	8.25		
13.15	3.00	5.33	6.58	6.47		
4.08	3.00	6.75	6.58	8.20		
6.78	3.00	6.67	6.58	8.11		
8.14	3.00	6.50	6.58	7.90	$23.10	$22.25
6.35	4.00	8.41	8.23	10.22		
7.08	4.00	8.19	8.23	9.95		
6.72	4.00	8.30	8.23	10.09	$28.71	$27.87

COTTON SEED MEALS.

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	NITROGEN		Ammonia Found %	Comparative Value Per Ton	
			Found %	Guarant'd %		Found	Guarant'd
Abbeville Cotton Oil Co., **Abbeville, La.** C. S. M. Fertilizer........	2269	1	7.05	6.00	8.57		
	2367	1	6.33	6.00	7.70		
	2533	1	6.92	6.00	8.41		
	2688	2	6.30	6.00	7.66		
	2843	2	7.13	6.00	8.67		
	2905	1	6.95	6.00	8.45		
	2961	1	7.18	6.00	8.73		
	3014	2	7.05	6.00	8.57		
	3074	1	6.83	6.00	8.30		
	3405	1	6.90	6.00	8.39		
	3535	1	6.99	6.00	8.50		
	3800	3	6.71	6.00	8.16		
	3858	3	7.03	6.00	8.54		
	4016	3	6.58	6.00	8.00		
	4125	4	6.99	6.00	8.50		
	4261	1	6.71	6.00	8.16		
	4297	1	7.06	6.00	8.58		
Average..................		29	6.85	6.00	8.35	$25.32	$22.60
Aberdeen Oil and Ice Co., **Aberdeen, Miss.** C. S. M. Fertilizer........	3957	1	7.19	6.00	8.74	$26.41	$22.60
Anguila Oil and Gin Co., **Anguila, Miss.** C. S. M. Fertilizer........	2901	2	6.63	6.00	8.06		
	3192	1	6.37	6.00	7.74		
	3273	1	6.40	6.00	7.78		
	4300	1	6.45	6.00	7.84		
Average..................		5	6.46	6.00	7.86	$24.07	$22.60
Arcola Oil Mills, **Arcola, Miss.** C. S. M. Fertilizer........	4147	1	6.79	6.00	8.25		
	4062	1	6.82	6.00	8.29		
	3954	1	6.63	6.00	8.06		
	3956	1	6.65	6.00	8.08		
Average..................		4	6.72	6.00	8.17	$24.90	$22.60

COTTON SEED MEALS.

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	NITROGEN		Ammonia Found %	Comparative Value Per Ton	
			Found %	Guarant'd %		Found	Guarant'd
Ashley Oil and Gin Co., **Wilmot, Ark.**							
C. S. M. Fertilizer	4139	1	6.69	6.60	8.13	$24.81	$24.52
Banner Cotton Oil Co., **Kentwood, La.**							
C. S. M. Fertilizer	3855	4	6.86	5.00	8.34		
	4206	1	6.62	5.00	8.05		
Average		5	6.74	5.00	8.20	$24.97	$19.40
Bastrop Cotton Oil Co., **Bastrop, La.**							
C. S. M. Fertilizer	3076	1	6.61	6.59	8.03		
	3679	1	6.37	6.59	7.74		
	3908	5	6.32	6.59	7.68		
	4144	1	6.37	6.59	7.75		
	4268	4	6.36	6.59	7.74		
	4298	1	6.31	6.59	7.67		
	4344	3	6.51	6.59	7.91		
	4391	1	6.35	6.59	7.72		
Average		17	6.40	6.59	7.78	$23.88	$24.49
Breaux Bridge Oil Works, **Breaux Bridge, La.**							
C. S. M. Fertilizer	2226	1	6.35	6.55	7.72		
	2400	1	6.73	6.55	8.18		
	2600	2	6.72	6.55	8.17		
	3201	2	6.88	6.55	8.36		
	3621	1	6.74	6.55	8.19		
	3859	2	6.67	6.55	8.11		
	4123	2	6.55	6.55	7.96		
	4203	3	6.64	6.55	8.07		
	4266	2	6.85	6.55	8.33		
	4302	6	6.76	6.55	8.22		
	4343	2	6.79	6.55	8.25		
Average		24	6.70	6.55	8.14	$24.84	$24.36

COTTON SEED MEALS.

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	NITROGEN		Ammonia Found %	Comparative Value Per Tou	
			Found %	Guarant'd %		Found	Guarant'd
Broussard Cotton Oil Co., Broussard, La.							
C. S. M. Fertilizer........	2599	7	6.57	6.22	7.99		
	2690	1	6.70	6.22	8.14		
	2899	2	6.61	6.22	8.03		
	3261	3	6.41	6.22	7.79		
	3400	4	6.69	6.22	8.13		
	3624	1	6.59	6.22	8.01		
	3856	5	6.70	6.22	8.14		
	4009	1	6.59	6.22	8.01		
	4119	1	6.52	6.22	7.92		
	4337	1	6.89	6.22	8.37		
Average..................		26	6.63	6.22	8.05	$24.62	$23.30
Buckeye Cotton Oil Co., Jackson, Miss.							
C. S. M. Fertilizer........	3079	5	6.79	6.18	8.25		
	3401	2	6.80	6.18	8.27		
	3469	3	6.88	6.18	8.36		
	4010	1	6.38	6.18	7.75		
	4070	1	6.97	6.18	8.47		
	4263	1	6.78	6.18	8.24		
	4415	1	6.31	6.18	7.67		
Average..................		14	6.70	6.18	8.14	$24.84	$23.18
Caddo Fertilizer Co., Shreveport, La.							
	2791	1	6.89	6.60	8.37		
	2962	1	7.15	6.60	8.69		
	3025	1	7.08	6.60	8.60		
	3075	1	6.75	6.60	8.20		
	3196	4	6.60	6.60	8.02		
	3270	1	6.45	6.60	7.84		
	3342	3	6.60	6.60	8.02		
	3399	2	6.60	6.60	8.02		
	3539	2	7.01	6.60	8.52		
	3623	1	7.07	6.60	8.59		
	3747	2	6.63	6.60	8.06		
Average..................		19	6.80	6.60	8.27	$25.16	$24.52

COTTON SEED MEALS.

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	NITROGEN		Ammonia Found %	Comparative Value Per Ton	
			Found %	Guarant'd %		Found	Guarant'd
Capital City Oil Co., **Baton Rouge, La.** C. S. M. Fertilizer........	3398	2	6.06	6.00	7.37		
	3683	1	6.55	6.00	7.96		
	4008	1	6.12	6.00	7.44		
	4262	1	6.80	6.00	8.26		
Average..................		5	6.38	6.00	7.76	$23.82	$22.60
Capital Fertilizer and Mfg. Co., Jackson, Miss. C. S. M. Fertilizer........	4333	1	6.48	6.00	7.88	$24.14	$22.60
Centreville Cotton Oil Co., **Centreville, Miss.** C. S. M. Fertilizer........	2598	3	6.63	6.00	8.06		
	3403	1	6.36	6.00	7.73		
	4012	1	6.64	6.00	8.07		
	4305	1	6.80	6.00	8.26		
Average..................		6	6.61	6.00	8.03	$24.55	$22.60
Cinclare Cotton Oil Co., **Cinclare, La.** C. S. M. Fertilizer........	3081	14	7.21	6.00	8.76		
	3195	1	7.94	6.00	9.65		
	3268	1	6.92	6.00	8.41		
	3346	1	6.92	6.00	8.41		
	3347	1	7.05	6.00	8.57		
	3538	2	6.95	6.00	8.45		
	3629	4	6.85	6.00	8.33		
	3684	1	6.76	6.00	8.22		
	3749	6	6.70	6.00	8.14		
	3905	1	6.94	6.00	8.43		
	3960	2	6.55	6.00	7.96		
Average.................		34	6.98	6.00	8.48	$25.74	$22.60
Columbia Cotton Oil Co., **Magnolia, Ark.** C. S. M. Fertilizer........	2604	1	6.98	6.75	8.48		
	3404	1	6.88	6.75	8.36		
	3857	3	6.82	6.75	8.29		
	3958	1	6.87	6.75	8.35		
Average..................		6	6.89	6.75	8.37	$25.45	$25.00

COTTON SEED MEALS.

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	NITROGEN		Ammonia Found %	Comparative Value Per Ton	
			Found %	Guarant'd %		Found	Guarant'd
Concordia Oil Mill Co.,							
Vidalia, La.							
C. S. M. Fertilizer........	3017	1	6.84	7.00	8.31		
	3072	1	6.47	7.00	7.86		
	3188	1	7.00	7.00	8.51		
	3275	1	6.71	7.00	8.16		
	3616	1	6.46	7.00	7.85		
	3692	2	6.44	7.00	7.83		
	4120	4	6.70	7.00	8.14		
	4224	1	6.78	7.00	8.24		
	4293	1	6.18	7.00	7.51		
	4364	1	5.71	7.00	6.94		
	4414	1	6.41	7.00	7.79		
Average..................		15	6.52	7.00	7.92	$24.26	$25.80
Crescent Cotton Oil Co.,							
Memphis, Tenn.							
Crescent C. S. M. Fertilizer	4072	2	7.32	6.50	8.90		
	4145	1	6.80	6.50	8.26		
Average..................		3	7.06	6.50	8.58	$25.99	$24.20
Eastman Oil Co.,							
Jonestown, Miss.							
C. S. M. Fertilizer........	3681	1	6.81	6.00	8.28	$25.19	$22.60
Eldorado Cotton Oil Co.,							
Eldorado, Ark.							
C. S. M. Fertilizer........	2251	1	5.73	6.77	6.96	$21.74	$25.06
Feliciana Oil Co.,							
St. Francisville, La.							
C. S. M. Fertiliezr........	3343	3	6.06	4.00	7.37	$22.79	$16.20
C. S. M. Fertilizer........	2602	1	5.71	6.00	6.94		
	2902	1	5.68	6.00	6.90		
	3338	2	5.93	6.00	7.21		
Average		4	5.77	6.00	7.02	$21.86	$22.60

COTTON SEED MEALS.

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	NITROGEN		Ammonia Found %	Comparative Value Per Ton	
			Found %	Guarant'd %		Found	Guarant'd
Fort Smith Cotton Oil Co., Fort Smith, Ark. C. S. M. Fertilizer	4146	1	6.40	6.50	7.78	$23.88	$24.20
Friar's Point Oil Mill and Mfg. Co., Friar's Point, Miss. C. S. M. Fertilizer........	2737	1	6.38	6.00	7.75	$23.82	$22.60
Glen Allen Oil Mill, Glen Allen, Miss. C. S. M. Fertilizer........	3083	1	6.63	6.00	8.05	$24.62	$22.60
Gloster Oil Co., Gloster, Miss. C. S. M. Fertilizer........	4061	1	7.08	6.59	8.60	$26.06	$24.49
Greensboro Cotton Oil Co., Greensboro, Ala. C. S. M. Fertilizer........	3078	1	6.42	6.00	7.80		
	3541	1	6.39	6.00	7.77		
	4376	1	6.68	6.00	8.12		
Average		3	6.50	6.00	7.90	$24.20	$22.60
Hazlehurst Cotton Oil Co. Hazlehurst, Miss. C. S. M. Fertilizer........	2270	1	6.87	6.00	8.35		
	2318	1	6.69	6.00	8.13		
	2416	1	6.89	6.00	8.37		
	2603	1	7.16	6.00	8.70		
	3137	1	6.26	6.00	7.61		
Average		5	6.77	6.00	8.23	$25.06	$22.60

COTTON SEED MEALS.

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	NITROGEN		Ammonia Found %	Comparative Value Per Ton	
			Found %	Guarant'd %		Found	Guarant'd
Homer Cotton Oil Co., Ltd., Homer La. C. S. M. Fertilizer........	2361	1	6.91	6.00	8.40		
	2415	2	7.14	6.00	8.68		
	2601	1	7.07	6.00	8.59		
	2738	1	7.00	6.00	8.51		
	2844	3	7.05	6.00	8.57		
	3133	1	6.65	6.00	8.08		
	3627	3	7.10	6.00	8.63		
	4356	1	6.98	6.00	8.48		
	4410	3	7.09	6.00	8.62		
	4419	1	6.66	6.00	8.09		
Average		17	6.97	6.00	8.47	$25.70	$22.60
Indianola Cotton Oil Co., Indianola, Miss. C. S. M. Fertilizer........	3194	1	6.82	6.00	8.29	$25.22	$22.60
Jackson Fertilizer Co., Jackson, Miss. C. S. M. Fertilizer........	4064	1	6.51	6.00	7.91	$24.23	$22.60
Lake Providence Oil Co., Lake Providence, La. C. S. M. Fertilizer........	3197	2	6.35	5.75	7.72	$23.72	$21.80
Lecompte Cotton Oil Co., Lecompte, La. C. S. M. Fertilizer........	2605	1	7.09	6.00	8.62		
	2787	2	6.91	6.00	8.40		
	2906	1	6.71	6.00	8.16		
	3198	6	7.54	6.00	9.16		
Average		10	7.06	6.00	8.59	$25.99	$22.60

COTTON SEED MEALS.

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	NITROGEN Found %	NITROGEN Guarant'd %	Ammonia Found %	Comparative Value Per Ton Found	Comparative Value Per Ton Guarant'd
Longbridge Cotton Oil Co. **Longbridge, La.** C. S. M. Fertilizer........	2897	7	6.13	6.59	7.45		
	3015	2	6.15	6.59	7.47		
	3269	1	6.24	6.59	7.58		
	3630	2	6.03	6.59	7.33		
	4141	1	6.03	6.59	7.33		
	4222	1	5.88	6.59	7.15		
	4267	4	5.98	6.59	7.27		
	4315	3	5.90	6.59	7.17		
Average		21	6.05	6.59	7.34	$22.76	$24.49
C. S. M. Fertilizer........	4334	1	6.50	6.50	7.90	$24.20	$24.20
Louisiana Cotton Oil Co., **Shreveport, La.** C. S. M. Fertilizer........	3540	2	6.40	6.30	7.78		
	3626	1	6.82	6.30	8.29		
	3748	1	6.57	6.30	7.99		
	4336	1	6.55	6.30	7.96		
Average		5	6.59	6.30	8.01	$24.49	$23.56
C. S. M. Fertilizer........	4334	1	6.50	6.50	7.90	$24.20	$24.20
Marianna Cotton Oil Co., **Mariannna, Ark.** C. S. M. Fertilizer..........	4339	1	6.56	6.00	7.97	$24.39	$22.60
Mississippi Cotton Oil Co., **Clarksdale, Miss.** C. S. M. Fertilizer........	4076	3	6.58	6.59	8.00		
	4226	1	6.37	6.59	7.75		
Average		4	6.48	6.59	7.88	$24.14	$24.49
Mississippi Cotton Oil Co., **Natchez, Miss.** C. S. M. Fertilizer	3631	5	6.59	6.59	8.01	$24.49	$24.49

COTTON SEED MEALS.

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	NITROGEN		Ammonia Found %	Comparative Value Per Ton	
			Found %	Guarant'd %		Found	Guarant'd
Natchez Oil Co., **Natchez, Miss.** C. S. M. Fertilizer........	3536	1	6.65	6.18	8.08		
	3690	2	6.59	6.18	8.01		
	3854	1	6.66	6.18	8.09		
	4075	3	6.45	6.18	7.84		
	4153	2	6.75	6.18	8.20		
	4230	2	6.23	6.18	7.57		
Average		11	6.56	6.18	7.97	$24.39	$23.18
New Iberia Cotton Oil and Manufacturing Co., **New Iberia, La.** C. S. M. Fertilizer........	2375	1	7.25	6.00	8.81		
	2384	1	7.52	6.00	9.14		
	2393	1	6.84	6.00	8.31		
	2435	1	7.03	6.00	8.54		
	2903	1	6.12	6.00	7.44		
	3543	1	6.88	6.00	8.36		
	3693	9	6.87	6.00	8.35		
	3860	4	6.90	6.00	8.39		
	4121	9	6.89	6.00	8.37		
	4341	1	6.95	6.00	8.45		
Average		29	6.93	6.00	8.42	$25.58	$22.60
New Orleans Acid and Fertilizer Co., **New Orleans, La.** C. S. M. Fertilizer........	2500	1	6.59	6.59	8.01		
	2959	1	6.59	6.59	8.01		
	3023	1	6.28	6.59	7.63		
	3267	1	6.80	6.59	8.26		
	4227	1	6.44	6.59	7.83		
	4257	1	6.47	6.59	7.86		
Average		6	6.53	6.59	7.93	$24.30	$24.49

COTTON SEED MEALS.

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	NITROGEN		Ammonia Found %	Comparative Value Per Ton	
			Found %	Guarant'd %		Found	Guarant'd
New Roads Oil Mill and Manufacturing Co., New Roads, La.							
C. S. M. Fertilizer........	3276	1	5.94	6.59	7.22		
	3805	5	6.17	6.59	7.50		
	3917	4	5.82	6.59	7.07		
	4138	1	6.74	6.59	8.19		
Average		11	6.17	6.59	7.50	$23.14	$24.49
Orleans Cotton Oil Co., New Orleans, La.							
C. S. M. Fertilizer........	3080	7	6.08	6.58	7.39	$22.86	$24.46
C. S. M. Fertilizer........	3344	4	6.64	6.60	8.07		
	3909	1	6.45	6.60	7.84		
Average		5	6.55	6.60	7.96	$24.36	$24.52
People's Cotton Oil Co., Lafayette, La.							
C. S. M. Fertilizer.......	2354	1	6.96	6.68	8.46		
	2898	5	6.75	6.68	8.20		
	3138	1	7.12	6.68	8.65		
	3189	1	6.50	6.68	7.90		
	3262	2	6.47	6.68	7.86		
	3395	5	6.63	6.68	8.06		
	3617	1	6.52	6.68	7.92		
	3685	1	6.87	6.68	8.35		
	3852	1	6.40	6.68	7.78		
	4063	1	6.73	6.68	8.18		
	4150	3	6.68	6.68	8.12		
	4202	3	6.60	6.68	8.02		
	4264	3	6.98	6.68	8.48		
	4295	1	6.94	6.68	8.43		
	4312	1	6.68	6.68	8.12		
	4365	3	6.53	6.68	7.94		
Average		33	6.71	6.68	8.15	$24.87	$24.78

COTTON SEED MEALS.

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	NITROGEN		Ammonia Found %	Comparative Value Per Ton	
			Found %	Guarant'd %		Found	Guarant'd
Planters' Oil Works, **Clarksdale, Miss.** C. S. M. Fertilizer.......	3274	1	5.68	6.50	6.90	$21.58	$24.20
Planters' Oil Mill, **Monroe, La.** C. S. M. Fertilizer.......	3751	1	6.31	6.20	7.67		
	3798	3	6.52	6.20	7.92		
	[illegible]073	2	6.46	6.20	7.85		
	[illegible]	5	6.74	6.20	8.19		
	[illegible]	1	7.09	6.20	8.62		
	[illegible]	3	6.58	6.20	8.00		
	[illegible]	1	6.50	6.20	7.90		
Average		[illegible]		6.20	8.02	$24.52	$23.24
Planters' Oil Mill, **Tunica, Miss.** C. S. M. Fertilizer.......	3959	2	6.17	6.50	7.50	$23.14	$24.20
Port Gibson Oil Works, **Port Gibson, Miss.** C. S. M. Fertilizer.......	4306	1	6.19	6.50	7.52		
	4307	1	5.80	6.50	7.05		
	4308	1	6.07	6.50	7.38		
Average		3	6.02	6.50	7.32	$22.66	$24.20
Rayne Cotton Oil and Manufacturing Co., **Rayne, La.** C. S. M. Fertilizer........	2355	1	6.83	6.00	8.30		
	2398	2	6.63	6.00	8.06		
	2434	1	6.67	6.00	8.11		
	3022	1	6.27	6.00	7.62		
	3202	2	6.89	6.00	8.37		
	3340	2	6.15	6.00	7.47		
	3402	1	6.76	6.00	8.22		
	3688	1	6.79	6.00	8.25		
	3752	4	6.76	6.00	8.22		
	3806	5	6.84	6.00	8.31		
Average		20	6.66	6.00	8.09	$24.71	$22.60

COTTON SEED MEALS.

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	NITROGEN		Ammonia Found %	Comparative Value Per Ton	
			Found %	Guarant'd %		Found	Guarant'd
Raccourci Cotton Oil Co., **Batchelor, La.** C. S. M. Fertilizer.......	2963	1	6.18	6.00	7.51	$22.18	$22.60
Red River Cotton Oil Co., **Alexandria, La.** C. S. M. Fertilizer.......	4350	1	5.92	6.17	7.20	$22.34	$23.14
C. S. M. Fertilizer.......	2845	1	6.22	5.76	7.56		
	3134	1	5.95	5.76	7.23		
	3190	1	6.59	5.76	8.01		
	3271	1	6.06	5.76	7.37		
Average		4	6.21	5.76	7.54	$23.27	$21.83
C. S. M. Fertilizer........	3625	1	6.66	6.00	8.09	$24.71	$22.60
C. S. M. Fertilizer........	3963	5	6.44	6.59	7.83	$24.01	$24.49
Richmond Cotton Oil Co., **Memphis, Tenn.** C. S. M. Fertilizer.......	4068	1	6.59	6.00	8.01		
	4143	1	6.29	6.00	7.64		
Average		2	6.44	6.00	7.83	$24.01	$22.60
Rose City Cotton Oil Co. **Little Rock, Ark.** C. S. M. Fertilizer.......	2908	1	6.68	6.00	8.11		
	3689	4	6.42	6.00	7.80		
Average		5	6.55	6.00	7.96	$24.36	$22.60
Shaw Cotton Oil Co., **Shaw, Miss.** C. S. M. Fertilizer........	3680	1	6.80	6.00	8.26	$25.16	$22.60

COTTON SEED MEALS.

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	NITROGEN		Ammonia Found %	Comparative Value Per Ton	
			Found %	Guarant'd %		Found %	Guarant'd %
Sonia Cotton Oil Co.,							
Alexandria, La.							
C. S. M. Fertilizer........	2606	1	6.76	6.76	8.22	$25.03	$25.03
Standard Guano and Chemical							
Manufacturing Co.,							
New Orleans, La.							
C. S. M. Fertilizer........	2408	1	7.03	6.47	8.54		
	3191	1	6.74	6.47	8.20		
	4165	1	5.23	6.47	6.36		
	4332	1	6.43	6.47	7.82		
Average		4	6.36	6.47	7.73	$23.75	$24.10
St. Landry Cotton Oil Co.,							
Opelousas, La.							
C. S. M. Fertilizer........	2596	4	7.20	6.58	8.75		
	2624	4	7.03	6.58	8.54		
	2689	1	7.38	6.58	8.97		
	2788	3	6.58	6.58	8.00		
	2900	2	7.14	6.58	8.68		
	2957	4	7.06	6.58	8.58		
	3139	4	7.10	6.58	8.63		
	3394	2	6.92	6.58	8.41		
	3530	1	7.14	6.58	8.68		
	3691	2	6.86	6.58	8.34		
	3799	3	6.95	6.58	8.45		
	3862	8	7.04	6.58	8.56		
	3904	1	7.00	6.58	8.51		
	4011	1	7.03	6.58	8.54		
	4116	1	6.66	6.58	8.09		
	4201	3	6.85	6.85	8.33		
	4256	1	6.78	6.58	8.24		
	4301	5	6.68	6.58	8.12		
	4327	3	6.98	6.58	8.48		
	4382	1	6.76	6.58	8.22		
Average		54	6.96	6.58	8.45	$25.67	$24.46

COTTON SEED MEALS.

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	NITROGEN Found %	NITROGEN Guarant'd %	Ammonia Found %	Comparative Value Per Ton Found	Comparative Value Per Ton Guarant'd
St. Martin's Oil Works, **St. Martinsville, La.** C. S. M. Fertilizer........	2499	8	7.12	6.00	8.65		
	2660	1	7.31	6.00	8.88		
	2904	1	7.07	6.00	8.59		
	2960	1	7.07	6.00	8.59		
	3016	1	6.96	6.00	8.46		
	3024	1	7.10	6.00	8.63		
	3199	2	7.04	6.00	8.56		
	3694	1	6.78	6.00	8.24		
	4124	4	6.61	..6.00	8.03		
	4204	4	7.10	6.00	8.63		
	4260	1	6.89	6.00	8.37		
	4304	6	7.02	6.00	8.53		
	4340	1	7.08	6.00	8.60		
Average		32	7.01	6.00	8.52	$25.83	$22.60
Sunset Cotton Oil Co., **Sunset, La.** C. S. M. Fertilizer........	3013	4	7.13	6.00	8.67		
	3205	3	7.00	6.00	8.51		
	3265	1	7.50	6.00	9.12		
Average		8	7.21	6.00	8.77	$26.47	$22.60
Tensas Cotton Oil Co., **St. Joseph, La.** C. S. M. Fertilizer........	4066	1	5.64	6.00	6.85		
	4314	1	6.00	6.00	7.29		
Average		2	5.82	6.00	7.07	$22.02	$22.60
Union Oil Co., Bunkie, La. C. S. M. Fertilizer........	2392	1	6.23	5.76	7.57		
	3200	3	5.86	5.76	7.12		
	3533	1	6.28	5.76	7.63		
	3907	3	6.12	5.76	7.44		
	4015	5	5.95	5.76	7.23		
	4148	1	6.25	5.76	7.60		
	4228	2	5.88	5.76	7.15		
	4351	1	6.01	5.76	7.30		
Average		17	6.07	5.76	7.38	$22.82	$21.83

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COTTON SEED MEALS.

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	NITROGEN		Ammonia Found %	Comparative Value Per Ton	
			Found %	Guarant'd %		Found	Guarant'd
Union Oil Co.—Continued.							
C. S. M. Fertilizer........	3135	1	6.02	6.17	7.31		
	3682	1	6.73	6.17	8.18		
	3853	1	6.27	6.17	7.62		
	3906	3	6.28	6.17	7.63		
	4117	1	6.32	6.17	7.68		
	4142	1	6.19	6.17	7.52		
	4258	1	6.33	6.17	7.69		
Average		9	6.31	6.17	7.66	$23.59	$23.14
C. S. M. Fertilizer........	2657	1	6.15	6.59	7.47		
	2658	1	6.17	6.59	7.50		
	2659	7	6.45	6.59	7.84		
	2735	3	6.03	6.59	7.33		
	2792	2	6.90	6.59	8.39		
	3021	1	6.19	6.59	7.52		
	3073	1	5.91	6.59	7.18		
	3203	6	5.99	6.59	7.28		
	3266	1	6.08	6.59	7.39		
	3345	1	6.53	6.59	7.94		
	3628	5	6.34	6.59	7.71		
	3687	1	6.40	6.59	7.78		
	3861	2	6.37	6.59	7.74		
	4017	1	6.72	6.59	8.16		
	4065	1	6.16	6.59	7.49		
	4140	1	6.04	6.59	7.34		
Average		35	6.28	6.59	7.63	$23.50	$24.49
Union Oil Co., Gretna, La.							
C. S. M. Fertilizer........	2464	1	6.89	6.59	8.37		
	2597	2	6.81	6.59	8.28		
	3140	4	6.18	6.59	7.51		
	3193	1	6.71	6.59	8.16		
	3397	2	6.24	6.59	7.58		
	3020	1	6.05	6.59	7.35		
	4014	6	5.93	6.59	7.21		
	4122	4	5.93	6.59	7.21		
	4152	6	5.76	6.59	7.00		
	4166	2	5.92	6.59	7.20		
	4231	1	5.79	6.59	7.04		
	4265	2	5.79	6.59	7.04		
	4313	1	5.72	6.59	6.95		
	4363	1	6.40	6.59	7.78		
	4375	2	5.27	6.59	6.41		
Average		36	6.09	6.59	7.41	$22.89	$24.49

COTTON SEED MEALS.

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	NITROGEN		Ammonia Found %	Comparative Value Per Ton	
			Found %	Guarant'd %		Found	Guarant'd
Union Oil Co., Monroe, La.							
C. S. M. Fertilizer........	2734	3	7.06	6.59	8.58		
	3020	1	6.12	6.59	7.44		
	3136	1	5.91	6.59	7.18		
	3204	4	6.36	6.59	7.74		
	3264	12	6.30	6.59	7.66		
	3339	2	6.33	6.59	7.69		
	3396	2	6.89	6.59	8.37		
	3532	1	6.04	6.59	7.34		
	3619	1	6.55	6.59	7.96		
	3802	2	6.30	6.59	7.66		
	3962	3	6.62	6.59	8.05		
	4074	2	6.65	6.59	8.08		
	4151	3	6.59	6.59	8.01		
	4225	1	6.61	6.59	8.03		
	4311	1	6.47	6.59	7.86		
	4338	1	6.47	6.59	7.86		
	4345	1	6.55	6.59	7.96		
	4357	1	6.40	6.59	7.78		
Average		42	6.46	6.59	7.85	$24.07	$24.49
Union Oil Co., Shreveport, La.							
C. S. M. Fertilizer........	2480	1	6.89	6.59	8.37		
	2623	1	6.84	6.59	8.31		
	2958	1	6.60	6.59	8.02		
	3019	1	6.53	6.59	7.94		
	3272	1	6.75	6.59	8.20		
	4067	1	6.51	6.59	7.91		
Average		6	6.69	6.59	8.13	$24.81	$24.49
C. S. M. Fertilizer........	4335	1	6.06	6.18	7.37	$22.79	$23.18
Union Oil Co., Torras, La.							
C. S. M. Fertilizer........	2736	3	5.90	6.59	7.17		
	2790	1	7.18	6.59	8.73		
	2846	5	5.93	6.59	7.21		
	3141	1	5.85	6.59	7.11		
	3961	3	6.36	6.59	7.73		
	4069	1	6.00	6.59	7.29		
Average		14	6.20	6.59	7.54	$23.24	$24.49

COTTON SEED MEALS.

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	NITROGEN		Ammonia Found %	Comparative Value Per Ton	
			Found %	Guarant'd %		Found	Guarant'd
Union Oil Co., Vidalia, La.							
C. S. M. Fertilizer........	3018	1	6.06	6.59	7.37		
	3263	4	5.92	6.59	7.20		
	3531	1	6.20	6.59	7.54		
	3618	1	5.67	6.59	6.89		
	3686	1	5.98	6.59	7.27		
	3754	1	6.05	6.59	7.35		
	4205	1	6.30	6.59	7.66		
	4296	1	5.68	6.59	6.90		
Average		11	5.98	6.59	7.27	$22.44	$24.49
Vicksburg Cotton Oil Co., Vicksburg, Miss.							
C. S. M. Fertilizer........	4071	1	6.54	6.18	7.95	$24.33	$23.18
C. S. M. Fertilizer........	4299	1	6.58	6.00	8.00	$24.46	$22.60
Washington Cotton and Oil Co., Washington, La.							
C. S. M. Fertilizer........	3534	2	6.44	6.00	7.83		
	3797	1	6.45	6.00	7.84		
	4013	1	6.38	6.00	7.75		
	4118	1	6.47	6.00	7.86		
	4259	1	6.31	6.00	7.67		
	4303	2	6.44	6.00	7.83		
	4342	2	6.21	6.00	7.55		
	4374	2	6.40	6.00	7.78		
	4383	1	6.30	6.00	7.66		
	4397	1	6.51	6.00	7.92		
Average		14	6.39	6.00	7.77	$23.85	$22.60
J. L. Wells Co., Memphis, Tenn.							
Star Brand C. S. M. Fertilizer	3537	3	7.41	6.10	9.01		
	3622	1	7.49	6.10	9.10		
	3801	3	7.52	6.10	9.14		
Average		7	7.47	6.10	9.08	$27.30	$22.92

CHEMICALS.

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	NITROGEN		Ammonia Found %	Comparative Value Per Ton	
			Found %	Guarant'd %		Found	Guarant'd
Caddo Fertilizer Co., **Shreveport, La.**							
Nitrate of Soda	3164	2	15.71	16.00	19.00	$50.27	$51.20
Gulfport Cotton Oil Fertilizer and Manufacturing Co., **Gulfport, Miss.**							
Primo Nitrate of Soda....	3048	1	15.30	15.00	18.60	$48.96	$48.00
New Orleans Acid and Fertilizer Co. **Gretna, La.**							
Nitrate of Soda..........	2953	1	15.80	16.00	19.20		
	3303	1	15.26	16.00	18.55		
	3491	1	14.62	16.00	17.77		
	3634	1	14.27	16.00	17.34		
Average		4	14.99	16.00	18.22	$47.97	$51.20
Planters' Fertilizer and Chemical Co. **New Orleans, La.**							
Nitrate of Soda..........	2239	1	14.43	14.00	17.54	$46.18	$44.80
Standard Guano and Chemical Manufacturing Co., **New Orleans, La.**							
Nitrate of Soda..........	2271	1	15.40	15.00	18.18		
	2376	1	14.58	15.00	*17.72		
	2462	1	15.31	15.00	18.61		
	2534	2	15.47	15.00	18.80		
	2655	1	15.00	15.00	18.23		
	2687	1	15.20	15 00	18.47		
	2786	1	15.70	15.00	19.08		
	2821	1	15.17	15.00	18.44		
	2989	2	15.19	15.00	18.46		
	3111	1	15.22	15.00	18.50		
	3163	2	15.16	15.00	18.43		
	3369	1	15.05	15.00	18.29		
	3438	1	15.34	15.00	18.65		
	3775	1	15.30	15.00	18.60		
	3827	1	15.25	15.00	18.53		
	4186	1	15.33	15.00	18.63		
	4251	1	15.34	15.00	18.64		
Average		20	15.24	15.00	18.49	$48.77	$48.00

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* Wet Sample

CHEMICALS.

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	NITROGEN		Ammonia Found %	Comparative Value Per Ton	
			Found %	Guarant'd %		Found	Guarant'd
Virginia-Carolina Chemical Co., Memphis, Tenn.							
Nitrate of Soda	4220	1	15.48	14.80	18.81	$49.54	$47.36
Virginia-Carolina Chemical Co., Shreveport, La.							
Nitrate of Soda..........	2877	1	14.81	14.80	18.00		
	3165	1	15.53	14.80	18.88		
	3492	1	15.40	14.80	18.72		
	3742	1	15.36	14.80	18.67		
	4137	1	15.85	14.80	19.26		
Average		5	15.39	14.80	18.71	$49.25	$47.36

CHEMICALS.

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	POTASH		Comparative Value Per Ton	
			Found %	Guarant'd %	Found	Guarant'd
Gulfport Cotton Oil, Fertilizer and Manufacturing Co., Gulfport, Miss.						
Primo German Kainit	2295	1	14.22	12.00		
	2331	1	14.12	12.00		
	3439	1	12.56	12.00		
Average		3	13.63	12.00	$10.90	$9.60
Hazlehurst Oil Mill and Fertilizer Co., Hazlehurst, Miss.						
German Kainit	2328	1	13.48	12.00		
	2785	2	14.28	12.00		
	4042	1	12.32	12.00		
	4405	1	12.76	12.00		
Average		5	13.21	12.00	$10.57	$9.60

CHEMICALS.

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	POTASH		Comparative Value Per Ton	
			Found %	Guarant'd %	Found	Guarant'd
Jackson Fertilizer Co., Jackson, Miss.						
German Kainit	2417	1	14.24	12.00		
	2465	1	14.64	12.00		
Average		2	14.44	12.00	$11.55	$9.60
Mississippi Fertilizer Co., Jackson, Miss.						
German Kainit	2296	1	13.48	12.00		
	2348	1	12.88	12.00		
Average		2	13.18	12.00	$10.54	$9.60
New Orleans Acid and Fertilizer Co., Gretna, La.						
Kainit	3304	1	14.28	12.00		
	3370	1	13.96	12.00		
	3633	1	13.76	12.00		
	3988	1	13.00	12.00		
Average		4	13.75	12.00	$11.00	$9.60
Planters' Fertilizer and Chemical Co., New Orleans, La.						
Planters' Kainit	2248	1	11.48	12.00		
	2479	1	14.56	12.00		
	2551	1	15.34	12.00		
	2820	2	13.88	12.00		
	2875	2	13.64	12.00		
	3305	1	14.96	12.00		
Average		8	13.98	12.00	$11.18	$9.60
Sonia Cotton Oil Co., Alexandria, La.						
Sonia German Kainit	3776	1	14.68	12.00	$11.74	$9.60
Standard Guano and Chemical Mfg. Co., New Orleans, La.						
Imported Kainit	2336	2	14.04	12.00		
	2356	1	14.64	12.00		
	2418	1	15.08	12.00		

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CHEMICALS.

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	POTASH		Comparative Value Per Ton	
			Found %	Guarant'd	Found	Guarant'd
Standard Guano and Chemical Mfg. Co.—Continued.						
	2516	1	14.76	12.00		
	2654	1	15.44	12.00		
	2929	1	14.72	12.00		
	3112	1	15.92	12.00		
	3162	4	15.32	12.00		
	3302	4	15.08	12.00		
	3371	1	14.88	12.00		
	3494	2	14.92	12.00		
	3741	1	14.32	12.00		
	3828	1	15.44	12.00		
	3884	1	13.68	12.00		
	4187	1	13.64	12.00		
Average		23	14.79	12.00	$11.83	$9.60
Swift's Fertilizer Works, Atlanta, Ga.						
Swift's German Kainit	3440	1	13.32	12.00	$10.66	$9.60
Virginia-Carolina Chemical Co., Jackson, Miss.						
German Kainit (Imported)	2338	2	13.84	12.00		
	2622	1	13.12	12.00		
	2686	1	14.16	12.00		
	3441	1	13.40	12.00		
Average		5	13.63	12.00	$10.90	$9.60
Virginia-Carolina Chemical Co., Memphis, Tenn.						
German Kainit (Imported)	3166	1	13.12	12.00	$10.50	$9.60
Virginia-Carolina Chemical Co., Shreveport, La.						
German Kainit (Imported)	2990	1	14.36	12.00		
	3169	1	13.28	12.00		
	3493	1	14.20	12.00		
Average		3	13.95	12.00	$11.16	$9.60

CHEMICALS.

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	POTASH		Comparative Value Per Ton	
			Found %	Guarant'd %	Found	Guarant'd
Gulfport Cotton Oil, Fertilizer and Mfg. Co., Gulfport, Miss.						
Primo Muriate of Potash	2332	1	59.60	50.00	$47.68	$40.00
New Orleans Acid and Fertilizer Co., New Orleans, La.						
Muriate of Potash	2952	1	54.88	50.00		
	2991	1	53.04	50.00		
	3632	1	52.40	50.00		
Average		3	53.44	50.00	$42.75	$40.00
Planters' Fertilizer and Chemical Co. New Orleans, La.						
Muriate of Potash	2249	1	52.00	48.00	$41.60	$38.40
Standard Guano and Chemical Manufacturing Co. New Orleans, La.						
Muriate of Potash..................	2294	1	52.48	45.00		
	2463	1	54.88	45.00		
	2582	1	59.20	45.00		
	2653	1	59.04	45.00		
	2874	3	55.76	45.00		
	2930	1	51.36	45.00		
	3168	2	54.88	45.00		
	3883	1	50.32	45.00		
	4413	1	53.65	45.00		
	4418	1	52.96	45.00		
Average		13	54.45	45.00	$43.56	$36.00
Virginia-Carolina Chemical Co., Memphis, Tenn.						
Muriate of Potash	4221	1	49.04	48.00	$39.23	$38.40
Virginia-Carolina Chemical Co., Shreveport, La.						
Muriate of Potash..................	2876	1	52.56	48.00		
	2954	1	54.24	48.00		
	3167	1	54.40	48.00		
Average		3	53.73	48.00	$42.98	$38.40

CHEMICALS.

Manufacturer or Jobber and Brand	Station Number	Number of samples composited	POTASH		Comparative Value Per Ton	
			Found %	Guarant'd %	Found	Guarant'd
Planters' Fertilizer and Chemical Co. **New Orleans, La.** Sulphate of Potash	3089	1	48.72	46.00	$38.98	$36.80
Standard Guano and Chemical Manufacturing Co., **New Orleans, La.** Sulphate of Potash	2297	1	49.68	47.00		
	2333	1	53.12	47.00		
	2378	1	53.84	47.00		
	2652	1	50.96	47.00		
	2819	1	52.32	47.00		
	2928	2	52.80	47.00		
Average		7	52.17	47.00	$41.74	$37.60
Virginia-Carolina Chemical Co., **Shreveport, La.** Sulphate of Potash	2955	1	50.08	48.50	$40.06	$38.80

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